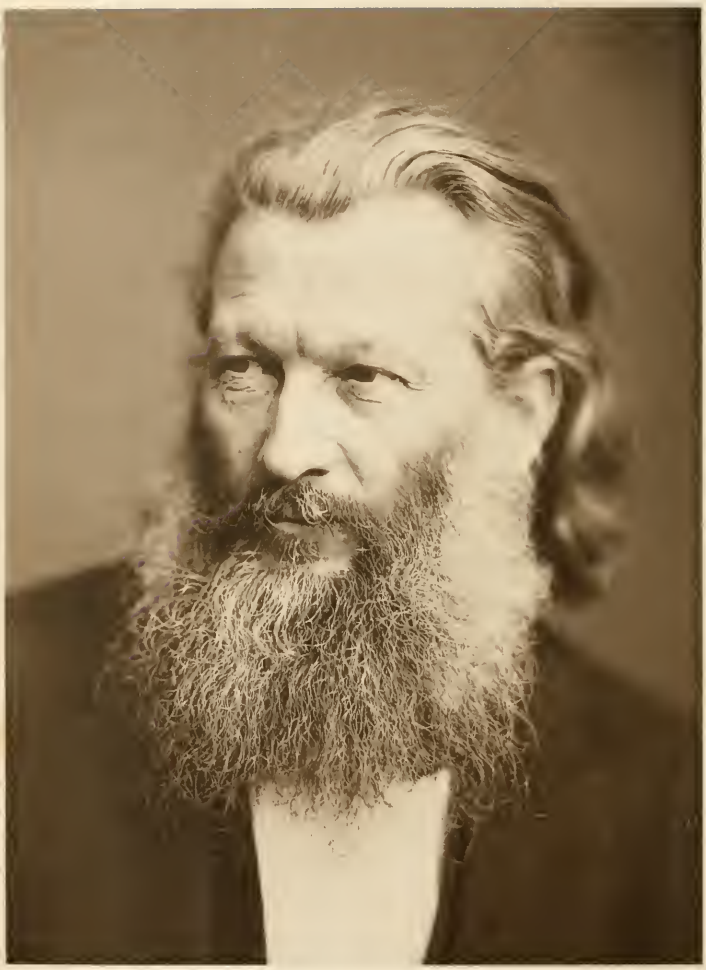
Vogel

THE PROGRESS OF PHOTOGRAPHY SINCE THE YEAR 1879.



W. KURTZ NEW YORK

A HEAD.

WITHOUT RETOUCHING

TAKEN BY ELECTRIC LIGHT WITH KURTZ'S POSING APPARATUS.

EMULSION PLATE ARTOTYPE PRINT BY F. BIERSTADT NEW YORK

THE

PROGRESS OF PHOTOGRAPHY

SINCE THE YEAR 1879.

A Review

OF THE MORE IMPORTANT DISCOVERIES IN PHOTOGRAPHY AND PHOTOGRAPHIC CHEMISTRY, WITHIN THE LAST FOUR YEARS,

WITH

SPECIAL CONSIDERATION OF EMULSION PHOTOGRAPHY, AND AN ADDITIONAL CHAPTER ON PHOTOGRAPHY FOR AMATEURS.

BY

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INTENDED ALSO AS A SUPPLEMENT TO THE THIRD EDITION OF THE HANDBOOK OF PHOTOGRAPHY.

TRANSLATED FROM THE GERMAN BY ELLERSLIE WALLACE, JR., M.D.

REVISED BY EDWARD L. WILSON, EDITOR PHILADELPHIA PHOTOGRAPHER.

WITH SEVENTY-TWO ILLUSTRATIONS.

PHILADELPHIA:
EDWARD L. WILSON.
1883.

PREFACE TO THE AMERICAN EDITION.

No apology is needed for the issue of another work by Dr. Vogel. For nearly twenty years he has contributed largely to the knowledge of American photographers by means of his monthly correspondence in the *Philadelphia Photographer*, and three editions of his excellent *Handbook*. Therefore, a warm welcome is confidently expected for this new contribution to our literature.

By his own request, I have revised and "Americanized" it as much as it would bear without damage, and have added from his correspondence such items of progress as have appeared since the issue of the German edition.

Dr. Wallace has given us an admirable translation, exercising, as he has, the most conscientious care throughout.

I commend the work to the craft with a knowledge of what it contains, and trust it will prove as useful as I anticipate.

EDWARD L. WILSON.

PHILADELPHIA, July, 1883.

NOTE FROM THE TRANSLATOR.

Believing that the usefulness of this work to the American public would be materially increased by substituting the English weights, measures, and thermometric scale, the translator has done so in almost every instance. The non-correspondence of the gramme or cubic centimetre with an *even* number of grains or minims has been the cause of the awkward form in which some of the formulæ necessarily stand. In some instances, as in the test for soluble haloids in emulsions, fractions of a grain even have been retained in the English, inasmuch as the slightest departure from strict chemical accuracy would render the tests unreliable and worthless.

Ellerslie Wallace, Jr.

PREFACE.

At no period of its highly interesting course of development has the Art of Photography been enabled to show such marked advances as within the last four years.

The old Collodion Process, which had been firmly established for more than a quarter of a century without a rival, suddenly found one in the highly sensitive Gelatine Dry Process, which unites certainty and ease of manipulation with good keeping qualities and clean results. By its aid, the photographing of moving and feebly illuminated objects was wonderfully facilitated, instantaneous and amateur photography received a fresh impulse, and results obtained by the employment of photography in art, science, and general industry which in earlier times would have been deemed impossible.

At the same time, the Electric Light offered itself as an important substitute for daylight in photographic studios, and made the portrait photographer independent of changes of weather. New and important Positive Processes, such as the Platinum, and various Direct Copying Processes, went hand-in-hand with the new Dry Process, so that the labor of the amateur, as well as of the engineer and man of science—who are employing the camera more and more—was sensibly lessened. Novel and excellent forms of Lenses, Instantaneous Shutters, and Landscape Apparatus did their part in diffusing and increasing the capacities of the Art in every direction. Many excellent chemists and scientific men devoted themselves to the investigation of

the problems of photographic chemistry, and by no means the smallest share of the said advances in the Art are owing to them.

The Author has set himself the task of giving a general review of the same, by selecting from among recently discovered facts only the more important ones—those that had been proved in practice, or those capable of further development, endeavoring to present them in brief, clear terms, such as are in ordinary use.

The book may also be regarded as a necessary addition to his already known *Lehrbuch* (Handbook), to which it bears a resemblance in the general division of the matter. The third edition of the *Handbook* had already appeared when the new discoveries forming the subject of the present volume could scarcely have been said to claim an existence.

Photographic Processes with the Printing Press, which have lately created a literature of their own, could be but alluded to; a detailed account of them would have made the book too costly, and lessened its universal circulation.

A supplementary chapter contains special advice to scientific men and amateurs.

The Author hopes that the book may be as kindly received as his *Handbook*.

Berlin.

CONTENTS.

CHAPTER V.

CHAPTER VI.

CHAPTER VII.

CHAPTER VIII.

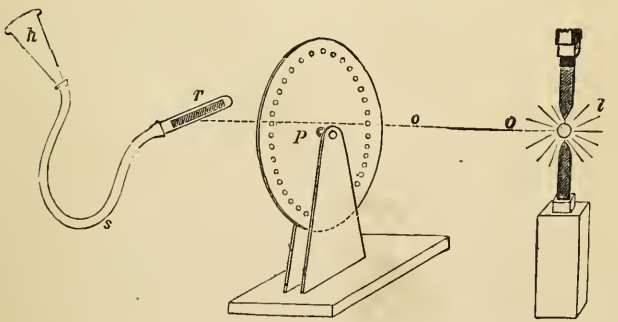
THE PROGRESS OF PHOTOGRAPHY.

CHAPTER I.

PHYSICAL EFFECTS OF LIGHT.

The Photophone.—Among the non-material (nicht stofflich) effects of light, those upon the element selenium are the most remarkable (Vogel, Lehrbuch, 13). A telephone placed in an electric current, passing also through a selenium plate, will respond,

FIG. 1.



if the latter be subjected to the influence of light and darkness following each other in rapid succession. This may be best effected by causing a cardboard disk (Fig. 1), with holes near its circumference,

to revolve before the selenium plate, and allowing light to fall upon the disk.

At the instant when a hole passes the opening, the selenium is illuminated, but is immediately darkened again. This intermitting illumination can also be effected from a distance if light be concentrated or focussed upon the selenium by means of a parabolic reflector. If speech be directed towards a thin mirror which also sends rays of light towards this distant reflector, the vibrations of the mirror set up by the words spoken reproduce themselves at the distant point, and become audible in the telephone, which is there in connection with the selenium plate. This is the principle of Bell's Photophone.

Radiophony.—Bell and Tainter found that not only selenium, but many other bodies in thin sheets, such as hard rubber, ebonite, metals, ivory, and paper, would give sounds under the influence of intermittent light, and this without the aid of an electric current, as in the case of selenium. This phenomenon may be called Radiophony. Many substances are acted upon in this manner, principally by the heat rays.[1]

Mercadier enclosed lampblack, cotton, woollen threads, and cork in a small tube, *r* (Fig. 1), connected with an ear-trumpet, *h*, and caused light to fall upon them through a revolving disk, *P*. Distinct sounds were given by all these bodies (Thermophone). Mercadier regards this capability of giving tones under the influence of the heat rays

[1] For further details, see Jahrbuch der Erfindungen, xvii. 110.

as a common property of matter. (Phot. Mitth., 1881, 200.)

Action of Light on Ebonite.—Hoorweg found that ebonite increased in length under the influence of light, and more noticeably so in the blue rays than in the red or yellow. He proved this with Edison's *Tasimeter.*—This apparatus consists of a stick of ebonite fastened at one end, while the other is brought into contact with a row of pieces of carbon, through which an electric current passes. If the stick of ebonite is lengthened under any influence, it will correspondingly affect the position of the pieces of carbon, whereby their electrical resistance is lessened, and the needle of the galvanometer included in the circuit deflected. Thus the tasimeter is an exceedingly sensitive thermometer.

Hoorweg caused a spectrum to fall upon the tasimeter in such a manner that the ebonite stick was exposed first to the red rays and afterwards to the blue, obtaining with the former a deflection of 10°, and with the latter 11° or 12°.

If these data should be verified, Edison's tasimeter would become a chemical photometer for the estimation of the intensity of the more highly refrangible rays, or, in other words, those chiefly effective in photography; and such an instrument also would be simple enough to offer a prospect of being employed in practice.

Photo-electricity.—Electricity is generated by light. Hankel recognized the electrical disturbances produced in crystals of fluorspar by light. (Phot. Mitth., xvii. 311). In crystals of the dark-green tint, the middle is negative, and the edges positive. The

electrical condition ceases in the dark within twenty-four hours. Chastaing recognized the same electrical conditions in guaiacum resin under the influence of light. (Ibid., xv. 29.) The action of light upon selenium also gives rise to an electric current. (Adams and Day, Naturf., 1876, 446.)

CHAPTER II.

CHEMICAL EFFECTS OF LIGHT.

A.—EFFECTS OF LIGHT UPON METALLOIDS AND THEIR COMPOUNDS.

Formation of Ozone in Light.—According to Boettcher, the action of light upon oil of turpentine in presence of oxygen does not generate ozone, but peroxide of hydrogen. Schöne also declares that the formation of the latter takes place in very many cases where it had been supposed that the former was produced. It is worthy of remark that, according to Downes and Blunt, the peroxide of hydrogen becomes slowly decomposed by the action of light. (Naturf., 20, 251.)

Amorphous Selenium becomes crystalline under the influence of light. As its electrical conducting power becomes better under these circumstances, we can thus explain the action of the selenium photometer.

Nitroprusside of Sodium is sensitive to light; still more striking is the behavior of a mixture of this substance with the alkaline sulphides. This mixture has a beautiful violet color, and by means of it we can detect very minute traces of sulphur. It is known that this color is unstable, and rapidly so; the author proved that this disappearance of color was caused chiefly by light.

If this fine violet solution be examined spectro-

scopically, a very distinct absorption band may be seen in the yellow and orange. If the examination be conducted by daylight, the band becomes gradually fainter and finally disappears more or less quickly, according to the chemical power of the light. If an instrument with Vogel's reflection apparatus, which shows two spectra side by side, be employed, the most delicate variations caused by absorption may be noted, and the disappearance of the band observed with a watch and the time required fixed upon.

Thus we are enabled to fix the chemical power of daylight in a very simple manner. The quicker the bands disappear with a given strength of solution, the more chemically powerful the light. It is not, however, the strength of the photographically effective *blue* rays that is thus determined, but that of the *yellow*, for these alone are absorbed by the violet-colored solution. This may be easily seen if a test-tube full of the solution be placed in a glass containing a solution of bichromate of potash, which allows only the yellow and red rays to pass. The sulphurous nitroprusside solution bleaches almost as quickly in orange light as in full open daylight. The blue rays have no action on the solution; therefore, in a blue glass, the solution bleaches but slowly. The solution must consequently be prepared in dark rooms glazed with blue glass, the precise opposite of the ordinary photographic dark-room.

In view of the fact that the effect of light upon dye-stuffs is always a bleaching one, it will be of interest to mention that one of the most famous of the dyes of antiquity—the purple of the Purpuracea—

was produced through the agency of light. According to Schunk, the purple snail contains a yellow substance soluble in ether and in alcohol, and which even without the presence of oxygen, under the influence of light, passes through green and blue to purple, giving off a garlicky odor. This dye is insoluble in alcohol or ether. If it were possible to obtain larger quantities of this substance, we might easily make purple photographic images by saturating paper with the original substance and exposing to light under a negative. (Phot. Mitth., xvi. 100.) Cole and Réaumur made similar observations in the last century. (Eder, Geschichte der Photochem.)

Oleococca Oil is described as sensitive to light by Fleury Hermagis, becoming hard, opaque, and wax-like. (Bulletin de la Soc. Francaise, 1881.)

Solutions of India-rubber change very quickly in the light (Eder and Toth), become thin, and give films partially soluble in alcohol and ether. Negatives made on an India-rubber substratum do not keep, the film easily lifting from the glass. At all events, this may be classed among the effects of light.

Photo-polymerism.—Numerous organic bodies under the influence of light become changed in their properties without experiencing a similar change in their ultimate composition. We may explain this as a change in the grouping of their molecular structure, and have chosen the above name by which to designate it. A change of this nature occurs in the case of *bromide of vinyl*, $C_2H_3Br_3$. According to D. M. Loof, water, air, and carbonic acid have no influence upon this process, but sulphuric acid accelerates

it considerably. A slight addition of iodine colors bromide of vinyl rosy-violet, if it is free from alcohol, and stops the polymerization completely until the color struck by the addition of the iodine has disappeared by exposure to light; then the liquid becomes dark again, owing to separation of the polymeric body. If a slight excess of iodine be present, the liquid will not change in daylight, but remains clear. The iodides of ethyl and methyl will impede the action of light because of their own decomposition, iodine being set free, and the solution of bromide of vinyl then remains unchanged in the light for a long time. Aniline likewise hinders decomposition by light, being acted upon itself, and assuming a reddish-brown color.

That variety of *anthracene* (mother-substance of alizarine) which is soluble in benzole is changed into insoluble paranthracene under the influence of light, but will regain its solubility if melted.

Chloral behaves in a similar manner, and *styrol* still more markedly so, becoming thick and insoluble in alcohol under the action of light; it regains its former properties; however, when heated to 570° F. (Lemoine, Phot. Mitth., xviii. 244.)

Action of Light on Asphaltum.—Kayser's recent researches upon asphaltum are of particular interest for practical heliography. He pointed out that the Syrian and Trinidad varieties can be separated into three principal constituent parts by the action of alcohol and ether—one soluble in alcohol, one in ether, and one insoluble in either menstruum. Thus, the Syrian variety contains about four per cent. of the matter soluble in alcohol, which appears as a

yellow oily mass, of a strong bituminous odor; also forty-four per cent. of the matters soluble in ether, which form a brownish-black, resinous, brittle mass, almost odorless, and melting at 150°; besides fifty-two per cent. of insoluble matter. The latter is a black, highly brittle, odorless mass, whose melting-point is 313°, easily soluble in chloroform and oil of turpentine, and with difficulty in benzole and petroleum. Its solutions possess a brownish-yellow color, and green fluorescence. The Trinidad variety is very similar, containing about five per cent. of matters soluble in alcohol, fifty-seven per cent. of those in ether, and thirty-eight per cent. of those insoluble in both. All three of these matters contain sulphur; in Syrian asphaltum the first contains about seven per cent., the second ten per cent., the third about thirteen per cent. According to Kayser's analysis, however, the soluble principles of both varieties of asphaltum have different compositions; he fixes upon the formula $C_{32}H_{46}S$ for the matter soluble in alcohol in the Syrian variety, but $C_{20}H_{30}S$ for that in the Trinidad variety; for the matters soluble in ether in the Syrian, $C_{64}H_{92}S_3$; and in the Trinidad, $C_{23}H_{34}S$. The insoluble constituents of both varieties of asphaltum, however, have the same composition, $C_{32}H_{42}S$.

Other varieties of asphaltum show different reactions, as, for instance, the Bechelbronn, which consists principally of carburetted hydrogen. On the other hand, the Maracaibo samples acted like the Trinidad and Syrian varieties.

The matter soluble in alcohol remains so in daylight, *but the others* lose their solubility when

exposed, the one insoluble in alcohol and ether being most strongly acted upon. This accordingly is the valuable constituent of asphaltum for heliographic purposes, the Syrian gum having fifty-two per cent. and the West Indian thirty-two per cent. Lately, purified samples have appeared in the market—*i. e.*, such as have had the soluble matters removed by extraction with alcohol and ether, thus being specially adapted to heliographic purposes.

Kayser holds the view that, when asphaltum is exposed to light, no oxidation takes place, as is commonly supposed, but merely a polymeric modification (see above). The reasons are that a plate prepared with asphaltum does not gain in weight upon exposure; solutions of the gum in closed bottles are also acted upon by light, becoming insoluble. Asphaltum which has become insoluble under the influence of light, returns to its former condition when melted.

Eder, nevertheless, believes that oxygen possibly plays some part in the photo-chemical changes of asphaltum. (Phot. Mitth., xvi. 228.) See Kayser's brochure for spectral reactions of the same.

Effect of Light upon Animals.—Moleschott and Fubini give the following results of experiments: Light is an active agent in the breaking-down of tissue; it increases the excretion of carbonic acid and the appropriation of oxygen. The effect of light in starting breath is seen in the case of the amphibiæ, birds, mammalia, and insects.

Chemical intensity of light increases the excretion of carbonic acid in the case of all warm- and cold-blooded animals, whether blind or with sight. The

same effect is produced upon birds and the mammalia by red and violet light, the latter having almost the power of pure white light, but the red being much weaker. The same relative power of violet light obtains in the case of frogs, red being without action (Naturf., 1880.)

B.—EFFECTS OF LIGHT UPON METALS AND THEIR COMPOUNDS.

The Double Salts of Iron and Oxalic Acid.

Ferric Oxalate (according to Eder, $Fe_2(C_2O_4)_3$) is soluble in water and alcohol, and uncrystallizable. Eder prepares it by dissolving $Fe_2(OH)_6$ in oxalic acid. It forms faintly basic salts — for instance, $Fe_2(C_2O_4)_3Fe_2(OH)_6 + 4H_2O$, which is insoluble in water.

The Double Salt, Potassio-ferric Oxalate (together with the corresponding salts of soda and ammonia), has been lately re-investigated by Eder. The emerald-green potassio-ferric oxalate ($Fe_2(C_2O_4)_6K_6 + 6H_2O$) dissolves at a temperature of 54° in fifteen times its volume of water, strikes a blue tint with ferrocyanide of potassium (the precipitate, however, rapidly redissolving), and, when made to react with ferric oxalate, gives a brown double salt that crystallizes badly, easily breaks down, and contains two equivalents less of oxalate of potash.

The double salt of sodium reacts in a similar manner, but is extremely soluble in water (at 63° in 1.7 parts of water). Formula: $Fe_2(C_2O_4)_6Na_6 + 11H_2O$. Commercial samples of the corresponding *double*

salt of ammonium ($Fe_2(C_2O_4)_6(NH_4)_6 + 8H_2O$) dissolved at 63° in 2.1 parts of water, and were easily decomposed by heat. All the ferric oxalates are directly sensitive to light.

Ferrous oxalate, on the other hand, is not decomposed by light; it combines with $K_2C_2O_4$ (neutral oxalate of potash) to form a very soluble double salt which is a powerful reducing agent (the well-known oxalate developer for dry plates). Formula: $Fe(C_2O_4)_2K_2 + H_2O$. The pure double salt easily decomposes, with the loss of FeC_2O_4; it keeps better if an excess of $K_2C_2O_4$ be present. A 40 per cent. cold solution of neutral oxalate of potash dissolves 9.37 per cent. of oxalate of iron; a 20 per cent. solution, only 4.9 per cent.

Ammonio-ferrous oxalate ($Fe(C_2O_4)_2(NH_4)_2 + 3H_2O$) reacts in a manner similar to the potassium salt. Under like circumstances, neutral oxalate of ammonia will dissolve almost as much oxalate of iron as the neutral oxalate of potash (see above).

Neutral oxalate of soda also forms a double salt with oxalate of iron. Its dissolving power, however, is less.

Sensitiveness of Iron Salts.—Eder publishes the following: Mixtures of chloride of iron with acetic and formic acids, as well as the iron salts of the same acids, are not sensitive to light. The double salts of iron and oxalic acid decompose most quickly in solution. In the case of the potassium compound, the reaction is as follows:

$$Fe_2(C_2O_4)_6K_6 = 2FeC_2O_4 + 3K_2C_2O_4 + 2CO_2$$

Eder has fixed the sensitiveness of the various iron salts *in solution* by the quantity of suboxide of iron

formed by a certain exposure to light. From this it appears that a mixture of chloride of iron and oxalic acid is the most sensitive. If we fix upon the number 100 to represent the quantity of suboxide of iron formed (with respect to subchloride of iron), we will have the following figures for the different solutions containing from one to five per cent. at temperatures varying from 63° to 68°:

Chloride of iron + oxalic acid, . . .	100
Ferric oxalate, ...	89
Ammonium ferric oxalate, ...	80
Potassium ferric oxalate, ...	78
Ferric tartrate, ...	80
Ammonium ferric tartrate, . . .	80
Ammonium ferric citrate, ...	15
Chloride of iron + citric acid, . . .	19
Chloride of iron + tartaric acid, . . .	15

With stronger solutions the sensitiveness is greater, and the difference between their behaviors becomes less. *Papers treated with these solutions behave in a surprisingly different manner.* Chloride of iron + oxalic acid is here also the most sensitive; next follows ferric oxalate: then the double salts of ammonium, sodium, and potassium. But the differences in sensitiveness are not as great as those given in the above table.

Eder recommends the sodium ferric oxalate for the iron printing processes. (Not yet in the market.)

The Iron Lichtpaus Process.[1]

Negative Reproductions from positive drawings are best obtained, according to Pizzighelli, with the fol-

[1] The term "lichtpaus" is applied by the Germans to the direct photographic reproduction of a drawing without first making a negative.—Tr.

lowing solution: 100 parts of water, 8 parts of red prussiate of potash, 10 parts of citrate of iron and ammonia. The mixture, according to the author's experience, keeps eight days. But it is better to dissolve each of the salts separately in 50 parts of water, and mix them as required. Paper brushed over with this and dried, gives, after exposure under a positive drawing, a negative copy, white on a blue ground. (Vogel, Lehrbuch, 432.)

Pizzighelli's Positive Blue Process.—As the foregoing iron process gives negatives, the following is given for obtaining positives[1] from positive originals. Mix together 1360 minims of a solution of gum Arabic (1 part of gum, 5 parts of water), with 51 minims of a solution of citrate of iron and ammonia, (1 part of the salt, 2 parts of water), and 85 minims of a solution of chloride of iron (1 part of chloride of iron, 2 parts of water).

This mixture gradually thickens, and therefore must be used soon. It is to be evenly spread over *well-sized* paper with a brush, and dried in the dark. It may be exposed for a few minutes under a drawing (longer in dull weather), until the fine lines of the original, which are white upon a black ground, become faintly visible; it is then to be brushed over with a solution of 1 part of yellow prussiate of potash to 5 parts of water. The picture quickly appears as a deep-blue positive. When all the details are out, the picture is quickly washed with water, and then laid in a pan containing dilute hydrochloric acid (1 part of acid, 10 parts of water).

[1] See "Anthrakotypie u. Cyanotypie von Pizzighelli, Wien Photo. Correspondenz.

The action of this is to clear up the lights and remove what is left of the gum and iron. Another washing is given, and the picture then dried.

The printing and finishing are very quickly done: in good weather the process may be ended within one or two hours. It is one of the most sensitive of the "paus" processes, (five times as sensitive as the carbon process). It is remarkable that red prussiate of potash develops the picture in the same way as the yellow. It is difficult to give a theory of the process. It has been supposed that those parts unacted on by light remain easily penetrable by the developer, so that they are acted on by the latter down into the body of the paper; while the parts that have been acted upon lose their penetrability, so that the developer can only work on the surface. Therefore, care is to be taken not to allow the developer to touch the back of the paper. A drawback to the process is that the acid wash-waters roughen the paper.

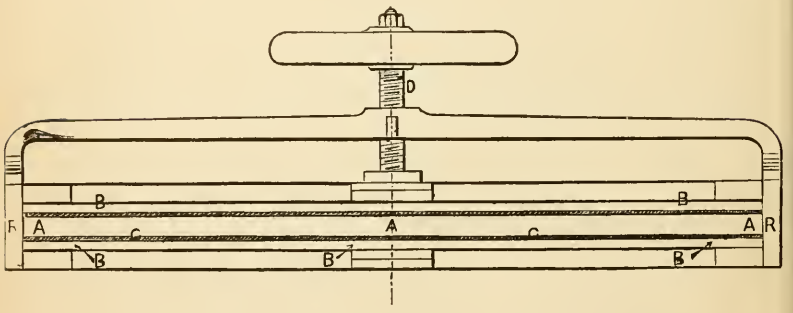
As in the case of all positive "paus" processes, under-printed proofs come out too dark, and become discolored where they should remain white, while over-printed ones are too light.

Cola's Positive Lichtpaus Process (Tintenprocess).—This process, also based upon the use of iron salts, and for which a patent has been granted in Germany (from July 29, 1880), gives positives from positives, and black lines on a white ground. Paper is coated with the following solution, which must be warm:

Sulphate of Iron,	154 grains.
Chloride of Iron,	340 minims.
Gelatine,	154 grains.
Tartaric Acid,	154 "
Distilled Water,	77 drachms.

Endless band paper is put upon a properly arranged system of rollers, and then drawn over the surface of the solution placed underneath in a tray; afterwards, it is hung up to dry. After the paper is dried, it must be kept away from the air, and it is accordingly placed in an apparatus resembling that shown in the accompanying figure, which

FIG. 2.



is a simple press, with two plates, *B B*, having India-rubber facings, *C C*. The sensitive paper is laid between the plates, and the screw, *D*, tightened. The India-rubber parts are forced out against the sides of the box, *R*, by the pressure, and so effectually protect the paper within from light and moisture.

The drawing to be copied must be drawn in deep-black lines either upon thin tracing paper, "paus" linen, or some other translucent material. It is then laid in an ordinary printing-frame. A piece of the sensitive paper, prepared side down, is then laid on the drawing, and the exposure conducted as usual. The greenish-yellow color of the prepared paper disappears on exposure to light, and only those

parts protected by the black lines of the drawing preserve their color. As soon as the ground-work of the paper has fully lost its color, it is immersed in a bath composed of

Gallic Acid, ...	6 oz. 200 gr.
Alcohol, ...	308 grains.

Afterward mixed with thirty-two ounces of water. The greenish-yellow lines immediately become black by the action of this bath; all that now need be done, is to wash the print well with clean water, which renders it permanent.

Actinium, a new Metal.

Actinium.—Phipson, in the Chem. News, 43, 283, 44, 33, gives an account of this metal, discovered by photo-chemical means. Its existence is still doubtful, however. If a solution of sulphate of zinc be mixed with one of sulphide of barium, a white precipitate falls. If any object be painted over with this, and exposed to the direct rays of the sun, the white color becomes transformed to brown, and finally into slate color at the end of about twenty minutes. If the object be now brought back to a dark room, its color will become white again in two and a half or three hours. *If the sun's rays be made to pass through a glass before reaching the white precipitate, no darkening takes place.* The composition of the precipitate is: Sulphate of baryta, 41.50 parts; sulphide of barium, 1.02 part; oxide of iron, 2.12 parts; oxide of zinc, 16.30 parts; sulphide of zinc, 37.44 parts; loss from calcination, 1.62 part; with traces of lead, arsenic, and manganese.

The change of color which takes place in sunlight is a reduction process, while the reappearance of the white will only take place where there is free access of air accompanied by oxidation. The sensitive element is sulphide of actinium.

The dark matter will dissolve in acetic acid, and may be precipitated by sulphide of ammonium as a dark-green powder, which becomes white by gradual oxidation, and shows reactions similar to those of zinc and iron. If the original white precipitate be treated for a long time with excess of acetic acid, the washed residuum on the filter will retain its actinic properties, so that the acid is proved not to have the power of dissolving this actinic substance before its exposure to light.

Phipson, from this, claims the existence of a new metal, *Actinium* (so called from the sensitiveness of its sulphur combination), as possible, and from the striking resemblance of the behavior of the precipitate in the light with the brown and darker colors of blende, he concludes that the former is contained in the latter.

Phipson further declares that he succeeded in separating oxide of actinium from oxide of zinc, by dissolving the oxide of zinc in an excess of caustic potash solution, in which the former was insoluble.[1] On account of the slight importance of this substance from a photographic point of view, we refer those interested to the Chem. News, as above.

[1] See Phot. Mitth., xviii. 178.

Salts of Copper.

Sensitiveness and Capacity for Development of Bromide of Copper.—Major Waterhouse has lately made pictures on bromide of copper in the camera; he also tried silvered and bromized copper plates. For bromizing, he used an aqueous solution of bromine, or, preferably, a five per cent. solution of bromide of copper, which gave very sensitive plates. Copper plates not silvered also become sensitive by this treatment. The silvered plates give an image with good details with an exposure in the camera about five or six times as long as wet plates. Bromized copper plates require longer exposures. Under a negative, a few seconds to daylight suffice. Before exposure the plates have a brownish-gray appearance; the silvered ones more of a yellow. Those where the exposure was short have a latent image, but longer exposures give a visible picture.

The latent image may be easily developed with the alkaline developer (pyro and ammonia, or ferrous oxalate), pyro giving a black picture, and iron a somewhat redder one. Weak cyanide of potassium is used for fixing; this makes the yellow ground clearer. Hyposulphite of soda also fixes, but the image breaks up under it.

The finished pictures are not unlike daguerrotypes, and are just as easily injured. This interesting process is still a doubtful one from a practical standpoint.

The Salts of Chromic Acid.

Gelatine Negatives as Lichtdruck Plates.[1]—Just as ordinary negatives can be prepared for the Lichtdruck process by special treatment, so may the gelatine negative (Pizzighelli); the latter requires a substratum of silicic acid and beer to prevent slipping of the film. The negative is not to be fixed, but is placed in a solution of bichromate of potash, 1 : 30, dried, then exposed from the reverse side (the exposure must be long), washed, and fixed (see Phot. Mitth., xviii. 172).

The Dusting On Process (Vogel, Lehrbuch, iii. 46) is now recommended by Pizzighelli (after Sobacchi), as a "lichtpaus" process, under the name of *Anthrakotype*. Instead of gum, he uses a solution of gelatine 1 : 30, on which the paper sheets are floated. After drying, they are again floated, and then hung up by the side, previously the lower one. The dried sheets are sensitized by an immersion of one or two minutes in a four per cent. solution of chromate of potash, dried in the dark, printed under a positive until a faint yellow image on a brownish ground is discernible, washed, dipped for two minutes in water at 86° F., then dried with blotting paper, and finally, finely powdered color (preferably lampblack) sifted on, which deposits most freely on the *unexposed* portions. The other parts also take some color, but after the picture is dry, they will part with it again if a damp sponge is passed over them. The drying is

[1] Lehrbuch, iii. 44.

done by gentle heat. (See Anthrakotypie u. Cyanotypie von Pizzighelli, Vienna, Phot. Correspondenz.)

According to the author's experiments, transparent positives require an exposure to 10° Vogel's photometer. The process is therefore about half as sensitive as the positive iron-blue process; it is not so convenient as the latter, but has the advantage that prints may be made in any desired color; and furthermore, over-printed proofs that are too weak, may be dusted a second time after the sponging, thus increasing the strength. Special parts also may be worked upon with the color, and thus made more prominent.

Itterheim's Negrographic Lichtpaus Process gives positive copies in black from positive originals. Drawing paper is coated with a solution of 7 parts of bichromate of potash, 25 parts of gum arabic, 100 parts of water, and 1 part of alcohol, and dried. When prepared, it will keep for some time. Five or ten minutes' exposure under a drawing is followed by immersion in cold water until the lines are distinctly visible; the print is to be blotted off with paper, and then thoroughly dried. It is then painted over with a color composed of 100 parts of absolute alcohol, 5 parts of shellac, and 15 parts of finest grape-black (Rebenschwärze), with a sponge. The print is then dipped into water containing two or three per cent. of sulphuric acid, until the color can be easily manipulated with a brush. The process is not as certain as the Anthrakotype or Cyanotype. (Phot. Mitth., xvii. 156.)

Stannotype.—This is the latest form of relief printing. (Lehrbuch, 43.) The last simplification of

Woodbury's relief process, is the dispensing with a heavy hydraulic press to transfer the impression from gelatine to lead. A sheet of tinfoil, which under slight pressure will follow the finest parts of the image, and which is afterwards stiffened by means of a thick backing of resin poured over it, becomes sufficiently resistant to serve as a printing plate (gelatine ink being used). Woodbury has made this process so practical, that he hopes to introduce it everywhere. In the "Bulletin de l'Association Belge," he offers the photographers of Belgium the right of working the (patented) process, together with all the necessary material for the cabinet size (rolling and printing presses, washing tanks, photometer, tinfoil sheets, paper, gelatine, ink, etc.), for $100 (500 francs). A matrix costs only 13 cents to make, and will print 500 prints at a cost of one-half cent each. (See Vidal, Photoglyptie.) A drawback to the process is that reversed negatives are required.

Transformation of a Gelatine Relief into the Printer's Block.—Printer's blocks are now made in America from photographic negatives by a process discovered by Ives. Apparently it is done in a mechanical manner by the cross-hatching (?) of a gelatine relief obtained by the Woodbury process, by means of an arrangement like the guillochir-machine, whose knife works upon the homogeneous half-tones, and, as it were, divides them up. Petit did something very similar with a wax-cast taken from the gelatine relief (see his somewhat obscure patent description in Phot. Mitth., xvii. 263). From the relief thus worked upon, a galvanoplastic impression may be taken.

Talbot's Heliographic Process.—Mariot, in Vienna, publishes the details of a heliographic process with etching (Lehrbuch, iii. 40). A thin plate of copper, zinc, steel, or brass is cleansed with tripoli, and treated with the following solution: water 630 parts, gum Arabic 63 parts, bichromate of potash 21 parts, grape sugar 9 parts; ammonia is added drop by drop until a straw-yellow tint is obtained, and finally 7 parts of chromic acid added. The solution is poured on twice, allowed to run off, and the plate then laid on a centrifugal machine to get rid of the excess, so that the film may assume the proper thinness; it is then allowed to set, and dried in an oven at 86° F. The exposure is carried to from 12° to 15° Vogel's photometer, by diffused light under a *glass positive*, and the principal portions unacted upon are coated with a negative varnish and dried. Then the etching fluid is poured on, and well spread over the plate with a brush. After about half a minute the heaviest lines, followed in four or five minutes by the finer ones, will appear if the etching liquid is of the right strength. The plate is then well washed to prevent further action of the fluid, cleaned with a mixture of equal parts of alcohol and caustic potash solution (a brush being used), and finally washed in water and dried with a linen cloth.

Chloride of iron is used for the etching. The solid salt is treated with one-quarter of its weight of water, allowed to dissolve with free access of air, and a trial made. If it works slower than is mentioned above, about one-tenth more water is added, and another trial made; if still too slow in action,

one-fortieth more water may be added. For details concerning the printing, see Phot. Corresp., xviii. 196.

Compounds of Mercury.

The red sulphide (cinnabar) is sensitive to light, at least that variety prepared wet. It changes in the light to the black amorphous modification, and most quickly so in the presence of an alkaline solution. Sulphur and mercury if shaken together in the dark, combine to form black cinnabar; if shaken in the light, to form red.

The sub-iodide behaves like iodide of silver in the light; it receives a latent image capable of development with pyrogallic acid. It is, however, not so sensitive as iodide of silver (Schnauss, Archiv. f. Pharm., vi. 416). This is of interest from the fact that besides the haloid salts of silver and iodide and bromide of copper, this is the only one that can be made to receive an image capable of development.

Amalgams (compounds of mercury with the various metals) possess the curious property of repelling greasy colors, so that practical application of it is made in photo-mechanical printing; *e. g.*, a line negative on collodion is dipped into bichloride of mercury (with formation of calomel and chloride of silver), and when transferred to copper forms an amalgam in such a manner that only the lines remain in pure copper and capable of taking the color. Fragility of the amalgam plates is an obstacle to the working of this process. Fisch publishes the following: If a drawing in mercury be applied to a well-polished, clean zinc plate, it will appear as a white image on the grayish-blue zinc. If the plate

be now laid in a bath of one hundred parts of water with two or more parts of nitric acid, an etching process will soon be set up, the acid attacking at first only the amalgamized spots, *i. e.*, the lines of the drawing, leaving the zinc quite unacted upon until the lines have obtained a depth enabling the plate to be used in the copper-plate press.

But the opposite will happen, if dilute sulphuric acid be used in place of nitric. This acts only on the bare zinc, leaving the amalgamized parts untouched; so that if the new precautions well known to etchers be taken, a relief may be obtained that can be used in the printing press. (Not so directly, however, for the reliefs contain sufficient amalgam to repel the ink. Vogel.)

If direct drawing on the zinc be undesirable, it may be done on stout paper with some salt of mercury; then the paper pressed on the zinc for a couple of hours, when, after removal of the paper, the drawing will appear as a white amalgam on the zinc just as if it had been originally done there. (Phot. Mitth., xviii. 284.)

The Relations of Iodide of Mercury to Hyposulphite of Soda.—Eder and Ulm studied the solubility of the former in the latter, and found that one molecule of iodide of mercury required two molecules of hyposulphite of soda to dissolve it. The solution decomposes on long standing, on evaporation *in vacuo*, or upon being warmed, when the separation occurs of a precipitate varying in color from yellow to vermilion, and consisting of varying proportions of the subiodide, iodide, sulphide of mercury, and free sulphur partly soluble in bisulphide of carbon and partly

not. When an excess of hyposulphite of soda is present, the precipitate is free from sulphur. Iodide of mercury dissolved in iodide of potassium has similar relations with hypo-soda.

The yellow precipitate which separates spontaneously from a solution of red iodide of mercury in hyposulphite of soda is sensitive to light, owing to the presence of the sub-iodide of mercury; it becomes black in the light. Even the solution is sensitive, throwing down from 1.03 to 1.12 times more deposit in the light than when kept dark. The precipitate formed under the influence of light contains more free sulphur than the other, the percentage of sub-iodide and sulphide remaining about the same.

Alcohol throws down HgS_2O_3 from the solution, $(Na_2S_2O_3)_2$ and HgI_2 $(NaI)_2$ remaining in solution. Metallic silver becomes changed into iodide, with simultaneous separation of sub-iodide of mercury.

From these reactions, the authors draw the conclusion that a double salt, HgI_2 $(Na_2S_2O_3)_2$, is formed when red iodide of mercury is dissolved in hyposulphite of soda, and that it remains in solution; alcohol effecting, as it were, a rearrangement of the bodies, and not a decomposition strictly speaking.

Eder's new Chemical Photometer with Oxalate of Mercury, for determining the Intensity of the Ultra-violet Rays of Daylight.—Bichloride of mercury is easily reducible in sunlight when mixed with organic substances. These mixtures under the influence of light break down into calomel (protochloride), partly in a pure and partly in an impure form. Among organic bodies, oxalic acid, and particularly oxalate of ammonia in aqueous solution, when mixed with

bichloride of mercury have been recognized as peculiarly sensitive. The calomel separated is pure. The mixed solutions of bichloride of mercury and oxalic acid decompose most quickly in the light, if a full amount of bichloride be present and as much oxalic acid as corresponds to the equation for the photo-chemical process:

$$2HgCl_2 + C_2O_4H_2 = Hg_2Cl_2 + 2CO_2 + 2HCl.$$

If a larger amount of oxalic acid than 1.5 per cent. to 6.5 per cent. of bichloride be used, the effect of light is not hastened; and if a less amount be used, it is very much retarded. But a mixture of bichloride of mercury with neutral oxalate of ammonia behaves most favorably. It is much more sensitive (20 to 100 times) than the mixture with oxalic acid or tetraoxalate. The sensitive solution with which the photometer is filled, consists of 2 volumes of a solution of 616 grains of oxalate of ammonia in 2.113 pints of water, mixed with 1 volume of a solution of 770 grains of bichloride of mercury in the same amount of water. This mixture contains a large excess of oxalate, so that the reaction proceeds with regularity. The decomposition effected by light may be expressed as follows:

$$2HgCl_2 + C_2O_4(NH_4)_2 = Hg_2Cl_2 + 2CO_2 + 2NH_4Cl.$$

If a large excess of bichloride be present, traces of a volatile organic acid, probably formic, will be observed.

The mixture may be kept in the dark without decomposition, and if heated to 212° F., for six hours without access of light, colors but faintly; while in the sunlight, even at ordinary temperatures, it colors

deeply within the space of a minute or less, and shortly afterwards a copious deposit of calomel falls.

Before use, the solution must be saturated with calomel; this may be best effected by exposing it to light until the precipitate begins to fall, then filtering. The more dilute the solution, the feebler is the effect of light; when four-fifths of the amount of bichloride in the solution has been decomposed, the light must act twice as long upon the remainder as upon the fresh solution, in order to separate a proportionate amount of calomel.

When the decomposition of the mercury solution in the light has progressed almost to the point of depositing all the bichloride in the form of calomel, then the calomel with excess of oxalate of ammonia begins to blacken under the influence of light, becoming partially reduced to the metallic form by the oxalate, aided by light. But if over 0.1 per cent. of the bichloride be present, the reduction to the metallic form does not take place.

This photo-chemical decomposition of the mercury solution takes place quicker at high than at low temperatures; being about twice as rapid at 122° as at 32°, and at 212° twenty times as rapid.

In order to be able to make comparative tests with this photometer, the influence of the constant dilution and change of temperature on the deposited quantity of calomel in this photo-chemical process of reduction, must be taken into account and allowed for. In the original treatise on the subject, tables specially made out for this purpose are given. Without the correction made by the tables, the

results for the separation of one gramme (15⅔ grains) per 100 cubic centimetres (1700 minims), would be about 20 per cent. out of the way, but with the correction, the difference is not more than + 1 per cent.

An investigation of the effects produced by the different colors of the spectrum upon the mixtures, showed that red, yellow, and yellowish-green have no effect, while the most marked action is in the ultra-violet. This has nine times the power of all the other visible rays together. Daylight, if passed through the sensitive solution, has no further effect upon it; the photo-chemical rays being thus absorbed by the process of decomposition.

The apparatus made use of for this photometric mercury solution, is a light-tight beaker glass, with an overhanging cover, having an opening for the admission of light cut in its centre. The number of milligrammes of calomel separated upon one quadratcentimetre of the horizontal surface exposed to the light is taken as the unit of actinism. (Sitzungsbericht d. Wiener Akademie, 1879, Bd. x.; Eder's Handb. der Phot. Halle bei Knapp, p. 169.)

Platinum Printing.

Within two years a "Platinotype Company" has been formed in London for working a printing process with the salts of platinum, discovered by Willis. The tone of the platinum print is pure black, somewhat cold, velvety in the deep shadows, with delicate gradations, and the high-lights pure white; the paper has no gloss, can be worked upon with crayon

or color, and gives the picture somewhat the appearance of an etching. Thus they are preferred by artists to silver prints on albumen paper; but the public in general will be better pleased by the silver prints on account of their gloss and warm tone.

Nevertheless, the process cannot fail to interest the amateur; he buys the paper ready sensitized, and can dispense with the manipulations of toning, fixing, and long washing, to which he was formerly accustomed, and requires very little apparatus; those not having a special room devoted to photography will appreciate these advantages.

The Platinotype Company supplies two varieties of sensitive paper: one with matt surface and one with rough surface.

According to Armstrong, the paper is prepared with a mixture of ferric oxalate and potassic chloroplatinite: 60 grammes (900 + grains) of each salt being dissolved in 480 grammes (7200 grains) of water, and the paper floated thereupon.

An indispensable condition to the successful working of the process is that all dampness be kept from the prepared paper both before, during, and after printing; damp paper gives bad results—flat prints without vigor and with dirty-gray lights; damp paper is also considerably less sensitive than dry.

For keeping the paper, cylindrical tin-boxes may be used, such as are furnished by the Platinotype Company, though they may also be made by any tinman. The cover has a small movable chamber pierced with holes, and filled with dried chloride of calcium; any dampness penetrating to the interior of the box is rapidly absorbed by this salt, the paper

thus being protected from injurious influences. If the chloride of calcium becomes saturated with moisture, it may be dried in an iron shovel heated over a fire. It can then be used again.

The paper, which has a lemon-yellow color, changes in printing: the shadows become gradually grayish-brown, and, in the case of over-printing, orange-yellow; the image is tolerably distinct, but it requires some practice to tell just the proper point at which to stop the printing; this, however, may soon be learned by a little observation. It is best to print with a photometer. The printing is three or four times as rapid as silver printing Care is to be taken that everything put into the printing-frame is thoroughly dry; and it is a safe precaution to lay a piece of India-rubber cloth back of the sensitive paper, so that the latter may be protected from dampness during printing.

The finished prints may either be developed immediately, or kept until the end of the day's work in a chloride of calcium box, as described above.

For development, a solution of four parts of neutral oxalate of potash in fifteen parts of distilled water is used, previously heated to 150°–170° F. in an agate-lined iron-pan. The process is conducted in subdued daylight.

The finished prints are floated upon this bath, which should cover the bottom of the dish to the depth of about a quarter of an inch, in the same way in which albumen paper is floated when silvering; or, if the prints are very large, they may be simply drawn over the surface of the solution; the development is almost instantaneous, and the picture

appears at once in its full strength. The rationale of the process is as follows: The ferric oxalate on the paper becomes reduced to ferrous oxalate, the platinum salt remaining unchanged:

$$\underset{\text{Ferric oxalate.}}{C_6O_{12}Fe_2} + \underset{\text{Potassic chloro-platinite.}}{K_2PtCl_4} = \underset{\text{Ferrous oxalate.}}{2C_2O_4Fe} + \underset{\text{Carbonic acid.}}{2CO_2} + \underset{\text{Potassic chloro-platinite.}}{K_2PtCl_4}.$$

By contact with the hot solution of oxalate of potash, the ferrous oxalate which has been formed dissolves, and reduces the platinum salt in those places which have been exposed to light to the metallic form as a black powder:

$$6C_2O_4Fe + 3K_2PtCl_4 = 2C_6O_{12}Fe_2 + Fe_2Cl_6 + 6KCl + 3Pt.$$

The temperature mentioned above for the developer answers well for prints made of the usual depth; under-printed proofs can be saved by using a hotter solution, and over-printed ones by a colder one. The developed prints are laid *without washing* in a pan containing a very weak solution of hydrochloric acid (1 part of acid to 80 of water), and left there for about ten minutes in order to remove the unchanged iron salt, the pan being rocked to and fro, and care taken that the acid solution reaches every part of the print. After this, the prints are to be laid in a second pan containing acid of the same strength (1 to 80) for ten minutes longer, and, if the solution assumes a yellowish tint, the acid must be renewed. After from an hour to an hour and a half's washing in frequent changes of water, the process is ended, and the prints are dried in the same manner as albumen prints and mounted on cardboard; if the paper on which the prints are

made is stout drawing-paper, mounting will not be necessary, for the prints have no tendency to roll up after drying.

It is evident, from the foregoing, that the process of developing and washing is extremely simple, and the materials reasonable in price: the pictures will not fade like silver prints, for the image consists of pure metallic platinum, which has no affinity for acids or alkalies, and can only be acted upon by hot nitro-hydrochloric acid, which, however, destroys the substance of the paper.

The developer can be bottled after use, and repeatedly used by filling up to the original bulk with fresh solution.

Old developers, spoiled prints, and trimmings are kept and treated for recovery of the platinum, as silver wastes are for silver.

The Salts of Silver.

Historical.—In relation to the historical development of our present photo-chemical knowledge, Dr. Eder has published a highly interesting series of articles in the *Phot. Correspondenz* for 1881, which will shortly appear in the form of a separate work. Space forbids us to do more than mention here the interesting fact that the first man who may be said to have attempted photography was a German physician, Johann Heinrich Schultze, of Halle. He copied handwriting with the aid of silver salts in the year 1727. He therefore must rank as the first inventor of photography.

The Various Modifications of Bromide of Silver, and the Chemistry of the Emulsion Process.

Preparation of Highly-sensitive Bromide of Silver.— The gelatine process, of which merely a sketch was given in Vogel's Lehrbuch, p. 397, has since that time been perfected in a wonderful manner, plates prepared by it having a sensitiveness three times greater than wet collodion. The process essentially consists in the addition of nitrate of silver to a solution of gelatine containing bromide of potassium; an emulsion is thus formed containing bromide of silver in a highly divided state. But its great sensitiveness shows itself only under certain conditions, of which the simplest are: long emulsification (Bennett, 1878), short cooking of the emulsion (Wortley and Mansfield, 1879), or the precipitation of bromide of silver in a gelatine solution at high temperatures, 140°–160° F. (Abney, 1880), or by means of ammonia (Van Monckhoven, 1879). The search for the reasons of this high sensitiveness has give rise to much scientific investigation which is yet far from being concluded. But it is to be remarked that this high sensitiveness, as the author was the first to recognize, shows itself *only under alkaline development;* while, if an acid developer be used, the gelatine plate manifests no higher sensitiveness than collodion emulsion. These facts have again turned attention to the researches of Stas (already noticed on p. 64, Lehrbuch), who, as early as 1874, had recognized a highly sensitive form of

bromide of silver. We here give a detailed extract from his interesting work.[1]

"*Forms of Bromide of Silver, according to Stas.*— Stas claims that there are six[2] distinct varieties: 1. In the flocculent, we have (a) the white, and (b) the yellow. 2. In the powdery, we have (a) bright yellow, (b) pearly-white. 3. In the granular, whitish-yellow. 4. In the crystalline or fused, bright pure yellow.

A. "*Flocculent bromide of silver* is formed if soluble bromides or hydrobromic acid, in solutions of one-half or one per cent., be added to a nitrate of silver solution *at a low temperature.* The cheesy precipitate is *pure white*, if an excess of the silver salt be present; *deep yellow*, on the other hand, if there be an excess of bromide.

"The white or yellow flocks break up rapidly if the solution is neutral, and if it is agitated; but slowly if it has an acid reaction.

"The white and yellow flocks, but particularly the yellow, cake together when left to themselves in the solution; and become, in time, a plastic mass retaining the color of the original precipitate.

"If the mass so formed be allowed to dry spontaneously, it shrinks together, forming a hard, opaque, resounding mass, resembling that formed by chloride of silver at a temperature of 400°

"Flocculent bromide of silver, both of the white and yellow varieties, becomes blackened (rather *darkened.* Vogel), very quickly, even in diffused

[1] See Annual d. chim. et phys., iii. 1874.

[2] In fact, we may reduce this to four; the flocculent, powdery, granular, and crystalline.

light, and in the caky condition, but the hard, resounding mass becomes only greenish.

"In a solution of an alkaline acetate, flocculent bromide of silver settles spontaneously."

B. "*Powdery bromide of silver* can be prepared from the flocculent variety by brisk agitation with water; very quickly, too, if precipitated from a neutral solution, but slowly if from an acid one. At the same time it changes color to a whitish-yellow, passing over into a condition of extreme subdivision. If mixed with water, it forms a pap-like mass, which if spread on linen, retains moisture with tenacity. If allowed to dry spontaneously in the dark, it cakes together, but remains powdery and whitish-yellow. It falls apart at the slightest touch; but if warmed after drying, it grows hard, and assumes a bright yellow color.

"In the pap-like condition, it is less changeable by light than the white flocculent variety; but if dried at an ordinary temperature, it changes much more rapidly than powdery chloride of silver."

C. "*Granular bromide of silver* may be prepared by throwing the flocculent or powdery variety previously mixed with water, into boiling water; a fine powder is instantly precipitated, which is the granular variety. It may also be directly prepared by adding a sufficient quantity of a very weak boiling solution of bromide of ammonium to a boiling solution of nitrate of silver, 1 : 1000.

"The granular powder obtained from flocculent bromide of silver, is of a *pale* yellowish-white color, while that obtained from the powdery variety, or from very weak solutions, is a *brilliant* yellowish-

white. After boiling for twenty-four hours, with frequent changes of water, the bromide of silver becomes more and more subdivided, until finally it is suspended in the water, making a milky solution. In this condition it shows decided light-reflecting qualities, and will only settle after standing for a very long time; after the supernatant liquid is poured off, it is then of a pearly-white color. By contact with a strong solution of bromide of ammonium, it instantly assumes a deep-yellow tint.

"Both the pale and brilliant yellow granular, and the pearl-white varieties of bromide of silver, are, of all substances with which I am familiar, the most sensitive to light. They may be darkened or changed in color by merely heating for two or three seconds in a glass flask over the pale-blue flame of a Bunsen burner."

D. The Solubility of Bromide of Silver in Water.— The flocculent and granular varieties are insoluble in pure water, and in water acidulated with nitric, sulphuric, and acetic acids, at temperatures between 32° and 92°; distinctly soluble, but in small amount, over 92°. The granular variety is only perceptibly soluble at temperatures over 120°, and then but slightly so. If solutions of the flocculent variety, prepared at temperatures over 92°, are made to react with solutions of bromide of potassium or nitrate of silver, they grow turbid.

Boiling water dissolves .0000003502 part of its weight of the granular variety (one million parts of water taking up three and a half parts of bromide of silver). If one per cent. of nitric acid be added to the water, it takes up one and a half parts more

(exactly, 5.4 to the million). Upon cooling a saturated solution of bromide of silver, that which has been dissolved is not all deposited. The solution retains a certain quantity, after the manner of other supersaturated solutions. The addition of one-tenth of a solution of bromide of potassium, or of the ordinary druggist's silver solution, causes the immediate deposition of the bromide of silver.

Stas further verified the slight solubility of the flocculent variety, in a cold solution of acetate of soda, one litre taking up .00029 part of bromide of silver at 60° *i. e.*, double as much as pure boiling water can take of the granular variety.

Photo-chemical Researches on the Different Varieties of Bromide of Silver.—Stas paid but little attention, in the course of his labors, to the more strictly photographic qualities of the various forms of bromide of silver. He made no experiments with developers, nor with gelatine solutions. It is therefore a matter of doubt which variety is formed in emulsion photography, but it is generally believed to be the granular. Van Monckhoven believes in the existence of two varieties only, the white (in collodion and in cold prepared gelatine emulsions) and the green or greenish-yellow, as found in cooked emulsions, or in those prepared with ammonia.

Eder also speaks of there being practically but two varieties, which he calls, after Stas, the "powdery" and the "granular."[1] He noticed that the former was transformed into the latter when gelatine emulsions were warmed, and that at the same time the

[1] Eder, Theorie u. Praxis der Bromsilberemulsionen, p. 9.

particles became perceptibly larger—after five days' cooking, increasing from .00008 to .0003 m.m.; also, the yellowish-red translucent film became bluish or grayish-violet in color.[1]

Besides their size, the green bromide of silver molecules are also distinguished from the white ones by their weight. It may be noticed during the coating of gelatine plates, that the green variety settles down, while the white remains above, so that the plate appears greener on the reverse side than on the face.[2]

Abney admits the existence of three varieties: the first, formed when bromized collodion or gelatine (cold) is acted upon with nitrate of silver, will admit the passage of yellow light; a second form also arising in collodion emulsion, admitting the passage of bluish-green light, and itself sensitive to red; and a third, contained in ripe gelatine emulsions, admitting the passage of gray light. (Proc. Royal Soc., 1881, No. 217.)

It is a most remarkable fact, that the highly sensitive variety of bromide of silver, has not yet been prepared in any other medium than gelatine. Stas indeed obtained a very sensitive one in water (see above), but he tested it by the degree to which it blackened in daylight only, not with developers.

Monckhoven maintains that the white bromide of silver, which darkens in direct sunlight, is the slowest to respond to the developer, while the green

[1] Eder takes this as a proof of the transformation into the highly sensitive variety; but it is not to be relied on.

[2] Stolze maintains that the plates are more sensitive on the reverse side.

variety, on the other hand, which only partially darkens on direct exposure, responds most quickly to the same.

Contrary to Eder, Abney maintains that not only long cooking, but also long standing of the solid emulsion in the cold, increases its sensitiveness.[1] According to his experiments, the emulsion after three days standing had gained threefold in sensitiveness. This seems to be true only of emulsions containing little gelatine. According to Cotesworth, a gelatine solution containing silver so thin that it will not set, becomes as sensitive after twenty-four hours' standing in the cold, as that which has been cooked for half an hour.[2] In the case of thick gelatine solutions, after forty-eight hours standing in the cold, the author could not detect any gain in sensitiveness. (For Eder's latest observations, see Practical Division.)

Sensitiveness of Bromide of Silver to Different Colored Lights.—The author has been lately[3] engaged in the study of the behavior of different kinds of plates to the spectrum, with the result that the bromide of silver as existing in collodion emulsion, as well as that prepared by the bath, was essentially different from that of the gelatine emulsion. That of collodion showed the maximum sensitiveness in the indigo of the spectrum (in the neighborhood of the sun line *G*, and remained tolerably constant to *h*),

[1] Phot. Mitth., xvii. 231.

[2] Phot. Mitth., xviii. 231. Recent experiments have shown that increase of sensitiveness in the cold is much less than Cotesworth believes.

[3] Phot. Mitth., xix. 34.

while that of the gelatine emulsion showed its maximum in the blue (about spiral length 450). This is true for all collodion emulsions, whether prepared with excess of silver or excess of bromide; also for all gelatine emulsions, whether prepared with or without heat, digested, or cooked. The effect of cooking or digestion is that the sensitiveness of the bromide of silver increases, not alone for the blue, but also for the other colors (red to clear blue, indigo to ultra-violet inclusive). But the maximum point is in the blue, and is more evident after "ripening" than before. *These characteristics remain the same even if the vehicle is changed;* as for instance, where the bromide of silver of the gelatine emulsion is transferred to collodion; so that, whatever may be the differences observed, they cannot be ascribed to the vehicle. (See *Philadelphia Photographer*, July, 1882, p. 221.)

The author accordingly makes the following distinctions: 1. *Bromide of silver sensitive to blue light* as existing in gelatine emulsion; of this, we have *a*, the highly sensitive variety (found in "ripe" gelatine emulsions); and *b*, the slightly sensitive variety (found in fresh cold prepared gelatine emulsions). 2. *Bromide of silver sensitive to indigo-colored light* (that found in collodion emulsion and in plates prepared in the bath). The two varieties spoken of by Abney under the names of "orange" and "translucent gray" bromide of silver in gelatine, are regarded by the author as merely modifications of the same variety. On the other hand, the translucent orange bromide of silver of cold prepared *gelatine* emulsion, is not identical with that of the same color found

in collodion emulsions, the latter being of the indigo-sensitive variety (2, above), and the former of the blue (1, ibid.).

The author places that variety of bromide of silver discovered by Abney as the *third*, and calls it the red-sensitive variety, from the fact that it shows a second maximum of sensitiveness in the red.[1] According to the author's experiments, the indigo-sensitive variety cannot be changed to the blue, merely by digesting or treating with ammonia. The latter is much influenced by the vehicle employed during digestion. Again, a digestion of the same with glacial acetic acid, or a mixture of collodion and gelatine (see below), does not increase sensitiveness. On the other hand, it is a curious fact that acids, such as glacial acetic, do not impair the sensitiveness of the blue-sensitive variety, even when present to the extent of fifty per cent., as is the case in Dr. Vogel's emulsion.[2]

The Effect of Ammonia upon Bromide of Silver.— As stated above, gelatino-bromide of silver becomes transformed into the blue-sensitive variety, not only when heated, but also by alkalies, particularly ammonia. This reaction is considerably hastened by heat, but in the case of long exposure to a high temperature, the danger of fogging is increased. Eder advises that the temperature be kept down to

[1] This red-sensitive AgBr is prepared with collodion as the vehicle by Abney, by acting upon a sample salted with bromide of zinc, with an alcoholic solution of silver nitrate restrained by nitric acid; after distilling off the solvents, the residue is washed, treated with alcohol, and dissolved in alcohol and ether.

[2] Phot. Mitth., xviii. 271.

104° F., if ammonia be present. The reaction between an alkaline bromide and an ammonio-nitrate of silver solution takes place with great rapidity. Ammonia (like the alkaline carbonates) affects the intensity as well as the sensitiveness; an action that may be seen within a few moments.

The Effect of Accelerators (Sensitizers) upon Blue-sensitive Emulsion Plates.—The effect of sensitizers is a favorable one here also, though not to the same degree as in the case of collodion emulsions. The author observed a favorable action of pyrogallic acid when mixed with gelatine emulsion, but a mere coating of the film with the pyro. had no special effect. Morphia mixed with the gelatine emulsion acted as a retarder. Nitrate of silver in collodio-gelatine emulsion (Vogel's) acts as an accelerator.[1] The author found that the addition of three drops of an alcoholic silver solution (1: 100) to eighty-five minims of the emulsion increased the sensitiveness one and a half times without fogging.

In addition to these facts, Stosch found that ordinary gelatino-bromide plates can be considerably increased in sensitiveness, if immersed in a mixture of 100 parts of alcohol at 85 per cent. (burning spirit), from 17 to 34 minims of nitrate of silver solution (1 to 15), and 170 minims of ammonia, allowing it to set for three or four minutes and drying. Such a plate had become four or five times more sensitive. But both Stosch and the author found that, at the end of twelve hours, the sensitiveness was not greater than at first, while the

[1] Phot. Mitth., xviii. 271

nitrate of silver became gradually decomposed by the gelatine.

In order to make plates with superior keeping qualities, Eder and Toth recommend for sensitizing, a solution of citrate of silver (154 grains each of citric acid and nitrate of silver, to 3 oz. 4 dr. of water). The plates are to be dipped for three or five minutes in a filtered mixture of the above quantity of alcohol, containing 9 minims of the citrate of silver. (For Eder's latest observations, see Practical Part.)

Stosch, however, could not obtain plates of good keeping qualities with this solution, and further declares that the presence of ammonia is essential.[1] The author verified the fact that many samples of gelatine act as reducers upon the salts of silver in presence of ammonia, but such reducing agents are almost always sensitizers. This has a direct connection with the increase of sensitiveness, brought about by immersion of the plates in a one per cent. solution of carbonate of soda. (Eder and Jastrzembsky.) The author found that if the carbonate of soda was removed from the plates by washing, there was no increase in sensitiveness, but only in intensity.[2] Caustic potash acts still more powerfully (Stosch). It is a remarkable fact that in the preparation of the emulsion (by precipitating bromized gelatine with salts of silver, and heating), an excess of the silver salt is hurtful, and causes fogging and insensitive plates. This abnormal effect when compared with its action on collodion, may be explained

[1] Phot. Mitth., xviii. 254. [2] Ibid, 271.

by the secondary action of nitrate of silver on gelatine, this action causing the "red fog" which destroys sensitiveness. It is beyond question, that a gelatine film once brought in contact with nitrate of silver solution, will not part with the silver even after long washing. Lohse maintains that nitrate of silver increases the viscidity of gelatine. The inefficiency of tannin as a sensitizer, may be explained by its coagulating effect on gelatine, thus rendering the film impenetrable to the developer. Morphia apparently has the same effect. Abney has proved that sulphate of quinine has a tanning action.[1] The theory that an organic sensitizer can only act as an accelerator if no other one be present, is not tenable. Two sensitizers only neutralize each other where they are chemically incompatible (*e. g.*, nitrate of silver and pyrogallic acid).

Warnerke has remarked a curious action of pyrogallic acid upon the gelatine film. He found that images developed with alkaline pyro were insoluble in warm water, and may be acted upon by it like a pigment (carbon) picture.[2] Vidal, however, found that the whole film frequently became insoluble in water[3] under the action of the pyro. It remains, however, soluble in dilute acetic acid, with the exception of the developed portions of the image.

Sensitiveness and Capability of Reduction.—It is supposed that light initiates a reduction of the haloid salts of silver, which is continued by the alkaline developer, thus making the latent image visible.

[1] Phot. Mitth., xvii. 88.
[2] Ibid., xviii. 48, 65.
[3] Ibid., 98, 235.

According to this theory, it would appear that the ripe blue-sensitive bromide of silver must be more readily reducible than the indigo-sensitive of collodion emulsion. But this is by no means the case.

The author proved that the "white" bromide of collodion emulsions, with equal exposure, was much more quickly reduced than that of collodio-gelatine plates, but that the latter, although developing much slower, was decidedly more sensitive—*i. e.*, there was much more detail in the dark shadows.[1] The objection that the gelatine influences the reduction cannot be urged, as, according to the author's experiments, the blue-sensitive bromide of the gelatine emulsion transferred to collodion, after being freed from gelatine, remained just as difficult of reduction.

The blue-sensitive bromide of silver is consequently more difficult of reduction, although more sensitive to light. The same is true of chloride of silver. This is decidedly more easy of reduction than the bromide, and yet far less sensitive.

The discrepancy, however, may be cleared up by considering the optical absorption relations. The blue-sensitive or so-called granular green bromide of silver is more sensitive to light than both the white variety and the chloride, because it absorbs the colored rays in a more marked manner than the latter and than the chloride.

In respect to capability of reduction by chemical means, the optical absorption relations, of course, play no part.

[1] Phot. Mitth., xviii. 12.

Effect of the Spectrum upon the different Varieties of Bromide of Silver.—As mentioned above on page 56, the two modifications of bromide of silver formed respectively in collodion or gelatine emulsions show marked differences spectroscopically. Observations made by the author have given the following details:[1]

1. Bromide of silver *in collodion*—whether prepared as emulsion or in the bath, whether with excess of nitrate of silver or bromide of potassium, whether exposed wet in presence of excess of nitrate of silver, or dry—will show a maximum sensitiveness near the Frauenhofer line G of the solar spectrum. The sensitiveness is tolerably constant from spiral length 410–438 (see Fig. 3, curve 1). 2. *Bromide of silver formed in gelatine solutions*, with or without heat—whether boiled or not boiled, digested or not digested—shows the highest degree of sensitiveness to the spectrum at spiral length 450. The sensitiveness is about equal from spiral length 430–460 (see Fig. 3, curve 2). Variations are, however, possible.[2] Boiling, digesting, and treating with ammonia materially increase (as has been stated by Monckhoven) the sensitiveness of the gelatine emulsion towards blue and the other color-lines—violet, ultra-violet, and green to red; this effect is not so marked for the feebly refrangible rays. 3. Gelatino-bromide of silver in Vogel's emulsion (containing glacial acetic acid with alcohol and

[1] Phot. Mitth., xxi. 33.

[2] See also Ueber die Schwankungen in der chemischen Wirken des Spectrums. Vogel, Berichte d. d. chem. Gesellsch., vii. 88.

pyroxyline) shows a maximum sensitiveness at almost the same point as plain gelatine emulsion (Fig. 3, curve 3), only a little nearer F., at about wave-length 460 : but, at the same time, an increased sensitiveness for green, verging towards red, is manifested—a proof that the composition of the sensitive film often has great influence upon its capability of being impressed by the various colors. 4. Collodio-bromide of silver undergoes no material change in sensitiveness to the spectrum if treated with a solution of gelatine in glacial acetic acid. 5. The so-called green bromide of silver, obtained, according to Eder, in collodion emulsion, by adding ammonia or by precipitating bromide of potassium in collodion with ammonio-nitrate of silver, is not identical with the green bromide of silver of the ripe gelatine emulsion, but acts, as regards sensitiveness to color, in a manner similar to the common collodio-bromide of silver emulsion—*i. e.*, the maximum is at G (see No. 1). The vehicle cannot be the cause of the difference, as shown in No. 4.

The striking differences in sensitiveness manifested by the salts of silver to the spectrum, particularly by the chloride, and in a less degree by the bromide at different times, may be explained by the variations in the chemical intensity of the spectral colors, according to the clearness of the atmosphere. The experiments noted above, regarding the sensitiveness of the various preparations, were comparative—*i. e.*, the different plates being exposed together or immediately after each other.

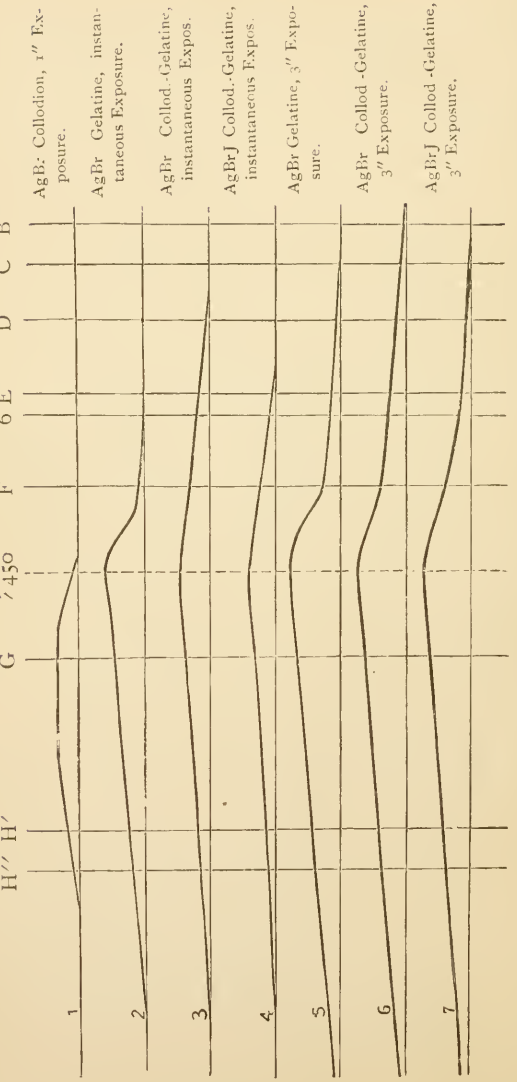
Abney has lately made exhaustive researches upon the effect of the spectrum on haloid salts of silver in

different media. He has concluded that the maximum sensitiveness of the different varieties of bromide of silver (in collodion and gelatine—Vogel's emulsion was not tried) is shown at the same point; this does not agree with the author's observations.

The latter prepared collodion emulsion plates, which, with one second's exposure, showed an action at G, but no trace of one at spiral length 450 (where gelatine emulsion was most strongly acted upon). Even after an exposure of twenty seconds, the action had not progressed to the point where the maximum effect was produced upon gelatine plates.

The discrepancy between Abney's results and those of the author cannot now be accounted for. But the author cannot but look upon the local conformity of the most marked action as improbable, taking into consideration the fact that the different varieties of bromide of silver show decidedly different colors; these, however, proceeding merely from different absorptions, which alone would cause a difference in the sensitiveness to color both qualitative and quantitative. Also, in relation to the maximum sensitiveness of chloride of silver, Abney's experience does not agree with that of the author. Nevertheless, the latter has been much interested in Abney's researches. Abney declared that the direct darkening in the spectrum of the three haloid salts of silver shows the same maximum point as exposure with development (acid or alkaline), and that it is not changed to any great degree by the presence of impurities.

Fig. 3.


H'' H' G /450 F 6 E D C B
AgBr Collodion, 1" Exposure.
AgBr Gelatine, instantaneous Exposure.
AgBr Collod.-Gelatine, instantaneous Expos.
AgBrJ Collod.-Gelatine, instantaneous Expos.
AgBr Gelatine, 3" Exposure.
AgBr Collod.-Gelatine, 3" Exposure.
AgBrJ Collod.-Gelatine, 3" Exposure.
1
2
3
4
5
6
7

Iodide and Chloride of Silver in Bromide Emulsions.— Of the three haloid salts of silver, the chloride is the most easily reducible, and the iodide least so. The latter, therefore, is least suitable for alkaline (chemical) development, where the image is made visible by a process of reduction. It is well known to be the contrary in the wet process with its (physical) acid development. An iodide emulsion with alkaline development shows but little sensitiveness. Therefore, an addition of iodide to a bromide emulsion decreases its sensitiveness. Notwithstanding, Captain Abney advises the addition of iodide of silver to the gelatino-bromide emulson, claiming that such emulsions (with iodide) are less sensitive to red light, so that they may be worked in better lighted dark-rooms without risk: he further calls attention to their freedom from fog. (Phot. Mitth., xviii. 64, 89.) The author's researches have also shown that an admixture of iodide of silver lessens sensitiveness to the red and yellow rays. The comparative results are given in Fig. 3, curves 4–7.

The author also verified the fact that an iodo-bromide emulsion containing one-fourteenth of iodide of silver is a little less sensitive (about one-tenth) than a pure bromide emulsion, but that it can be developed in a comparatively strong orange-light without fear of fogging. He has prepared plates at a distance of six inches from a lamp with an orange (not red) chimney, and exposed them to the light for many minutes without the slightest ill-effect. This circumstance led him to add a little iodide of silver to his emulsion, particularly because in its preparation a tolerably strong light is required.

The addition of chloride of silver to the bromide emulsion is not beneficial. Nevertheless, Eder advocates it (see Practical Part).

Gum and Collodion Emulsion.—Eder obtained increased sensitiveness with gum Arabic emulsion, either digested or treated with ammonia. Compared with gelatine, however, it is much inferior in this respect. The digestion of collodion emulsions gives entirely negative results. Treatment with ammonia apparently produces the "green modification," giving a preparation almost as sensitive as gelatine.

Solarization (Blurring).—Gelatino-bromide plates solarize very easily—*i. e.*, the high-lights, when allowed to act to excess, take on a reversed action, and come out pale in development, or the plate may even assume the character of a positive instead of a negative, if the over-action be long continued. This will happen if the exposure given be about 1000 times as long as the proper timing for a good negative should be. In the case of landscapes taken in summer, the high-lights are frequently solarized and positive, the dark parts negative.

According to Jannsen, the following phases of development show after a very long exposure to direct sunlight: 1. The picture is negative, $\frac{1}{500}$ of a second being sufficient. 2. The plate gets dark all over. 3. It becomes positive. 4. It again darkens all over. 5. It becomes negative; for the production of this negative of the second order, a million times longer exposure than that of the original negative is required.

Solarization takes place, according to Abney, only in the presence of oxygen, and is favored by oxidizing

bodies; he maintains that the exposed iodide or bromide of silver combines with the oxygen to form a substance incapable of development. Plates exposed in hydrogen gas, or in a solution having reducing properties, do not, therefore, solarize. Plates exposed in oxidizing solutions solarize more quickly than those exposed in ordinary air. (Photo. News, xxiv. 28.)

The property possessed by oxygen of accelerating solarization has been utilized by Bolas to facilitate the *reproduction of negatives by means of gelatine plates.* A gelatine plate is dipped in a four per cent. solution of bichromate of potash, and afterwards in a fifty per cent. alcohol solution for a few seconds. The plate is then laid flat, blotted off with bibulous paper, and dried (of course, in the dark). The plate is then exposed under a negative about as long as required by a carbon print—a visible positive image is formed—after which the plate is washed in water and developed with pyrogallic acid and ammonia. The image then changes to negative, and is fixed as usual.

Eder remarks that plates that have already been exposed to light solarize more easily than those that have not been; and that strong developers are more apt to produce the phenomenon than weak ones.

The effect is dependent upon the vehicle used. The author observed that collodio-gelatine emulsion plates solarized far less easily than gelatine plates.

Evanescence of the Latent Image.—To the peculiar effect of oxygen or ozone may be attributed the fact that exposed undeveloped plates lose the impression made by light after a longer or a shorter time: seven

months[1] in the case of gelatine (Noël), and two months in the case of collodion emulsion. The rapidity of the change in the latter may be explained by a gradual decomposition of the pyroxyline, the strongly oxidizing nitrous acid being set free. Reducing bodies, like tannin, consequently retard the disappearance of the image in collodion emulsion plates, but it gradually loses its power by the oxidation of the air. Gelatine, also, as a feebly reducing body, has a favorable effect, and the fact that gelatine plates never contain free nitrate of silver is also of advantage (Eder). If it be known that a long time must intervene between exposure and development, the photographer is compelled to give long exposures: collodion emulsion requiring eight times the otherwise necessary exposure if twenty days are to elapse. The disappearance of the latent image begins with a decrease of vigor in the high-lights and shadows, followed by apparent loss of sensitiveness—*i. e.*, loss of detail in the shadows.

Destruction of the Invisible Image.—Chlorine, bromine, iodine, or substances containing them, ozone and oxidizing bodies, such as nitric and nitrous acids, chromic acid and its salts, permanganic acid and its salts, sulphuretted hydrogen, and carburetted hydrogen, destroy the latent image upon bromide of silver. These bodies consequently are prejudicial to emulsions, destroying sensitiveness when present even in small amount. They may only be used as

[1] According to Wight, gelatine plates will often retain an impression for two and a half years. He obtained a picture after this lapse of time, but the plate showed incipient decomposition.

fog-destroyers (*e. g.*, the addition of iodide or chromate of potassium to emulsion).

Restrainers.—Just as there are accelerators of the action of light, so there are retarders. (Lehrbuch, p. 71.) Iodide of potassium is the most powerful, the bromides less so, the chlorides least; cyanide of potassium also has a retarding effect. Restrainers act by hindering the process of reduction. Therefore, they are used in developing. The chemical (alkaline) developer would act upon the shadows as well as the lights, if some substance to control its action were not present. The principal one is some soluble bromide (of potassium or of ammonium). Chloride of sodium and other chlorides are much feebler. The alkaline bromides, therefore, are chiefly employed.

Another energetic restrainer of development is *gelatine*. Therefore, when gelatine plates are developed with iron, the addition of bromide is not always necessary.

The efficiency of gelatine in preventing fog is most manifest in the case of collodion emulsion plates, which frequently fog under the strong alkaline developer used for the gelatine plate. The author coated collodion emulsion plates with a solution of one part of gelatine in five parts of glacial acetic acid and fifteen parts of alcohol. They dried quickly, *and bore the strong alkaline developer without fogging.* The plates, when compared with ordinary collodion plates, showed a marked increase in sensitiveness (Phot. Mitth., xviii. 11)—a proof that the gelatine also acted as a sensitizer.

Developers for Bromide of Silver Plates.—The high sensitiveness of the green variety of bromide of silver is (as the author pointed out—Phot. Mitth., xvii. 272) not apparent under the acid, but under the *alkaline* developer. While the easily reducible white bromide of silver of collodion plates will only bear the weaker forms of the alkaline developer (carbonate of ammonia), the green variety of bromide of silver, which has been already mentioned as difficult of reduction, will bear much stronger developers, such as would immediately fog the collodion plate—*i. e.*, would act upon the parts not previously influenced by light.

Pyrogallic acid and caustic ammonia are the chemicals generally used, glycerine (Edwards) or sugar (Nelson) being often added to prevent fog. Of the new developers investigated by Lea (Lehrbuch, p. 77), only one has become important, the ferrous-oxalate developer.

Formerly, the oxide of iron was dissolved in a solution of neutral oxalate of potash; but now the developer is usually made by mixing concentrated solutions of oxalate of potash and sulphate of iron; this is the preferred form of developer for gelatine plates.

It has a less favorable action on Vogel's emulsion. A remarkable fact, however, is that its developing power is considerably increased by the addition of a small amount of hyposulphite of soda, probably owing to the formation of a compound of hyposulphurous acid and iron, which is a powerful reducer. The other developers recommended by Lea (ferro-

phosphate, borate, and tartrate; Phot. Mitth., xvii. 85), have not sustained their claims. (Eder.)

Among the new developers for emulsion plates, the mixture of carbonate of soda and pyrogallic acid may be mentioned. Its action is more energetic on Vogel's emulsion than on gelatine plates; it gives very intense pictures. (Eder first tried it on collodion emulsion.)

Prussiate of potassa in the developer was proposed by Henderson, but not extensively tried. It is not now used.

The hydrokinone developer was first proposed by Abney. It gives clear shadows without the addition of bromide. Eder asserts that sixteen grains of hydrokinone dissolved in a little less than an ounce of water, with a few drops of ammonia, works better than a two per cent. pyro solution. At present the article is very costly. But Nietzki has discovered, it is said, a cheap method of manufacture, by the oxidation of aniline with bichromate of potash. He claims that he can reduce the price to one-twelfth. (Formerly the development of a 5 x 8 inch plate, with hydrokinone, cost about twenty-four cents. At this rate, the cost would be reduced to about two and a half cents, or not much more than that of the ferrous-oxalate developer, say 1.92 cents.)[1]

Negatives developed with ferrous-oxalate are bluish-black; those with pyro more brownish, and those with hydrokinone intermediate between the two.

[1] Eder claims that sixty-one grains (costing twelve cents) are necessary; pyro development would cost one and a quarter cents.

Theory of Intensification by Alkaline Development.— If the alkaline developer be allowed to act for some time upon a developed image, the deep as well as the superficially acted upon parts will be reduced, so that *intensification* of the developed image follows. Eder pointed out that this effect was of an electro-chemical character. Having laid a fine silver wire on an unexposed bromide of silver plate, he treated it with ferrous-oxalate developer. The part in contact with the silver wire was reduced. This reduction takes place more into the substance of the film (downwards) than laterally, so that, if fogging is prevented, no ill-effect consequent upon the widening or spreading of the outline can be observed.

Photo-chemistry of Chloride of Silver.

The Different Modifications of Chloride of Silver.— According to Stas, chloride of silver, like the bromide, may appear in various forms (Lehrbuch, p. 63). Eder[1] and Pizzighelli maintain that this may be seen in photographic processes also, particularly in the gelatino-chloride process. A freshly prepared gelatino-chloride emulsion is orange-red when examined in thin films by transmitted light (Eder); after twelve or twenty-four hours' digestion at 95° or 104°, violet: after half an hour's boiling, blue. The sensitiveness increases also, but far less than that of bromide of silver emulsions similarly treated. Such

[1] Die Photographie mit Chlorsilbergelatine u. chemischer Entwicklung, von Eder u. Pizzighelli, Wien, Verlag der Phot. Corr. 1881.

emulsions give, moreover, thin, weak pictures. For the author's experiments, see below.

Ammonia and its carbonate (in a less degree) increase sensitiveness like heat, but give pictures of greater strength, and a peculiar color. Of the various chlorides, those of zinc and cadmium give very clear but hard images: those of the alkaline metals, softer and more delicate ones.

Sensitizers work favorably on both varieties of chloride of silver; morphia having the most marked action, gallic acid and tannin less. Ammonia has an excellent effect, combining with the chloride of silver to form an ammonio-chloride, which is very sensitive both to the direct action of light, and to development. The color of the image on ammonio-chloride is darker.

The behavior of chloride of silver which has had but short exposure (*i. e.*, having an impression only appearing on development) to various reagents, agrees so strikingly with that exposed until darkening has taken place, that it cannot be doubted that subchloride of silver is formed by the short exposure also.

Solarization of chloride of silver (incapacity of darkening under development after prolonged exposure) only occurs after a relatively longer exposure than in the case of bromide of silver; it is seen oftener with strong than with weak developers. Solarized bromide of silver is affected by nitric acid; properly exposed bromide of silver is not. (It is probable that solarization consists in the formation of metallic silver. V.)

The sensitiveness of chloride of silver under development is much less than that of the bromide. The proportion, according to E. and P., after trial with the photometer, is about 1 : 45 : that is, 4 to 20 of the instrument (Scalenphotometer). Therefore, chloride of silver is not suited for the negative process, even with development.[1] Metallic chlorides and various acids have a restraining effect on sensitiveness. (Lehrbuch, p. 71.)

The lesser sensitiveness of chloride of silver, compared to the bromide, is remarkable, when it is remembered that the former is decidedly more susceptible of reduction by chemical means than the latter. The reason is, that the chloride has much feebler absorption power for the rays of light than the bromide (see p. 62).

Developer for Gelatino-chloride Plates.—The ordinary developers for bromide plates act so violently upon

[1] E. and P. tried plates as follows, and fixed the comparative exposures required :

Gelatino-bromide plate,		ferrous-oxalate developer, .	1
Collodio-bromide,	"	acid sulphate of iron " .	5–7
Collodio-iodide,	"	" " " " .	4–5
Gelatino-chloride,	"	citrate of iron and ammonia developer, . . .	50
"	"	" citrate of iron and ammonia (and a trace of hypo soda),	10
"	"	" alkaline pyro and hypo, .	6–8
"	"	" pyrogallic acid alone, . .	100
"	"	" hydrokinone, . . .	150
"	"	" hæmatoxylin and ammonia,	500
"	"	" exposed until a visible image appeared, . . .	150–200
"	"	" exposed until a vigorous image was obtained, .	18000–45000

those prepared with the chloride, that they attack the unexposed portions, causing fog. Bromide of potassium may be used here as a restrainer, but it is too powerful; common salt is better. E. and P. propose as developers—1. Citrate of iron and ammonia, with pure citric acid. (Citrate of soda cannot be used in place of ammonia, as it works very slowly.) 2. Hydrokinone with one and a half times its weight of carbonate of ammonia. Or, 3. Hæmatoxylin[1] with the same salt (the latter works more slowly and colors the film red). Neutral aqueous pyrogallic acid of from one-half to one per cent. strength. This develops a good picture on chloride of silver, having hardly any effect on the bromide. (Lehrbuch, p. 69.) E. and P. have also tried pyro and bicarbonate of soda, gallic acid and ammonia, tannin and ammonia, pyrokatechin[2] and carbonate of ammonia.

The color of the pictures obtained with the various developers, depends upon the method of preparation of the emulsion, and the development. Thus, an emulsion prepared with ammonio-nitrate of silver, or a digested emulsion, gives a dark picture. Citrate of iron and ammonia gives a brown color, or with a trace of hyposulphite of soda, blue to grayish-black. The shorter the exposure and the longer the development, the darker is the color obtained.

[1] Dissolve 108 grains of extract of logwood in 3 oz. 4 dr. of alcohol. Dilute 51 minims of this with 3 oz. 4 dr. of water, and add from 2 dr. to 1 oz. of carbonate of ammonia solution (1 to 30), and from 4 to 5 dr. of a solution of common salt (1 to 30). The mixture is of a deep-red color.

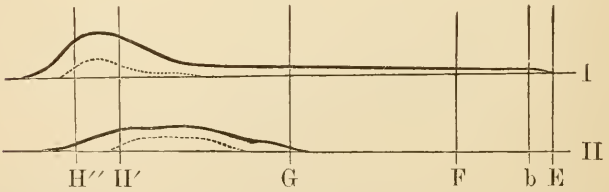
[2] A substance obtained by the destructive distillation of catechu. —Tr.

Effect of the Spectrum on Gelatino-Chloride of Silver.— E. and P. found the maximum sensitiveness (in March) at F $\frac{2}{3}$ G. The maximum remained almost at the same spot, the sensitiveness for other colors varying considerably according to the character of the emulsion.

Abney maintains that the maximum remains in the ultra-violet, both in collodion and gelatine plates. (Proceed. Royal Society, 1881, No. 217.) Great differences will doubtless be observed at different times (as the author observed with collodio-chloride plates: Lehrbuch, 148), inasmuch as the penetrability of the air for the different colors varies.

Violet and Ultra-violet Sensitive Chloride of Silver.— In order to determine whether the precipitation of chloride of silver in different vehicles (collodion or gelatine) caused the same differences as with bromide of silver (see page 63), the author examined gelatino- and collodio-chloride plates by the spectroscope, and found decided differences.

FIG. 4.



Collodio-chloride of silver, whether made by the bath or as emulsion, and exposed either wet or dry, shows its maximum sensitiveness in the violet at about spiral length 410. The sensitiveness remains

about the same from 4,000 to 4,140 (see curve II., Fig. 4).

Gelatino-chloride emulsion made by Eder's formula, shows its maximum sensitiveness near the two H′ lines (Frauenhofer), and remains tolerably constant from 309 to 403 spiral length. Towards the ultra-violet, the sensitiveness of these plates increases rapidly. Towards red, the increase is at first rapid to H, followed by a gradual decline (see curve I.).[1] The author distinguishes accordingly between violet-sensitive, and ultra-violet-sensitive chloride of silver (the former in collodion, the latter in gelatine emulsions).

Chloride of silver shows still more striking differences of sensitiveness to the spectrum at different times than bromide of silver, depending upon the condition of the atmosphere (page 64). The above-mentioned experiments with the sensitiveness of preparations, were always so arranged that the plates were either exposed simultaneously or immediately after one another.

E. and P. have worked out a *practical positive process* with gelatino-chloride of silver and development; it can be used by gaslight. (See Practical Part.)

Comparative Sensitiveness of Albumen Paper and Wet Plates.—The author proved that wet plates with development are at least 2,500 times more sensitive than silvered albumen paper without development; *i. e.*, if exposed until a sufficiently vigorous image is obtained, it will require at least 2,500 times more

[1] The dotted curves are for the short exposures. The long ones for the longer.

ight than a well-timed negative. After investigations with gelatino-chloride plates, Eder claims a still higher difference in the latter case, which is not surprising when it is remembered that chloride of silver without free nitrate is very insensitive.

Rare Salts of Silver.

Sensitiveness of Fluoride, Chlorate, and Perchlorate of Silver.—Wolfram has ascertained the following concerning the photo-chemistry of these rare salts: 1. If solutions of fluoride of sodium, or chlorate or perchlorate of potash, be mixed with nitrate of silver, no fluoride of silver is formed, and no chlorate or perchlorate of silver. 2. Fluoride of silver in the presence of reducing organic bodies, is more sensitive than the chlorate, perchlorate, and nitrate. 3. The fluoride, chlorate, and perchlorate when used as sensitizers for iodide of silver, do not shorten the necessary time of exposure, and have no advantage over the nitrate. 4. No sensitiveness of the fluoride to yellow light could be observed. (Phot. Mitth., xvi. 35.)

CHAPTER III.

PHOTOGRAPHIC CHEMISTRY.

Bromide of Ammonium.—The solubility of this salt, now so extensively used for the preparation of emulsions, is (Eder)—

At	50° F.	in 1.51	parts of water.
At	60° F.	in 1.39	" "
At	86° F.	in 1.23	" "
At	122° F.	in 1.06	" "
At	212° F.	in 0.28	" "

Also at 60° in 31.5 parts of alcohol sp. gr. 0.794. An appreciable quantity of ammonia is given off upon boiling, an advantage in emulsion-making with gelatine, inasmuch as the acid reaction tends to prevent fog.

Different Forms of Pyroxyline.—Wolfram and Eder have advanced our positive knowledge in this direction by their late researches. (Phot. Mitth., xv. and xvi.) Eder regards the different pyroxylines not as nitro-derivatives of cellulose, but as nitrates (salts of nitric acid), for the reason that when treated with cold sulphuric acid, they give off nitrogen in the form of nitric acid, just as any of the other salts, and because alkalies easily abstract varying quantities of nitric acid from the pyroxyline. Eder doubles the formula of cellulose, and names the following varieties of pyroxyline (Lehrbuch, p. 114).

Cellulose-hexanitrate—$C_{12}H_{14}O_4(NO_3)_6$, containing 14.14 per cent. of nitrogen

Cellulose-pentanitrate — $C_{12}H_{15}O_5(NO_3)_5$, containing 12.75 per cent. of nitrogen.

Cellulose-tetranitrate—$C_{12}H_{16}O_6(NO_3)_4$, containing 11.11 per cent. of nitrogen.

Cellulose-trinitrate—$C_{12}H_{17}O_7(NO_3)_3$, containing 9.15 per cent. of nitrogen.

Cellulose-dinitrate—$C_{12}H_{18}O_8(NO_3)_2$, containing 6.76 per cent. of nitrogen.

The first is the well-known insoluble *gun-cotton.* It does, however, contain small quantities of soluble matter.

The pentanitrate appears as a by-product during the preparation of the hexanitrate, and may be distinguished from the former by its solubility in a mixture of ether and alcohol. Eder obtained it during the digestion of cotton in a mixture of equal parts of sulphuric and nitric acids (sp. gr. 1.4), at the ordinary temperature, lasting from one to five hours. In alcohol mixed with but little ether, it will not dissolve. By this it may be distinguished from the tetra and trinitrate which are also formed at the same time.

Eder obtains the *tetranitrate* from the formula given on page 119 of the Lehrbuch, giving an immersion of fifteen minutes at 176°. The excellent celloidin of Schering corresponds to this.

But trinitrate is also always formed together with the tetranitrate. Eder did not succeed in separating them, although the two show marked differences in behavior. The *tetranitrate* (or properly, collodion cotton, containing a large amount of it) is insoluble in pure ether or alcohol even by heat, but easily

soluble in a mixture of ether and alcohol, acetic ether, wood spirit, and mixtures of acetic acid and alcohol, or acetic acid and ether. It is scarcely soluble in cold glacial acetic acid, and only with difficulty in the same acid boiling. (Every sample of Schering's celloidin tried by the author, dissolved easily in cold glacial acetic acid of 99 or 100 per cent.)

The *trinitrate* (or those cottons containing large amounts of it) is gradually dissolved by absolute alcohol at ordinary temperatures; a large excess of ether will render its concentrated solution (in the same menstruum) milky. It is freely soluble in acetic ether, wood spirit, and boiling glacial acetic acid.

This must be understood as the true cellulose-trinitrate, and not as a mixture of the tetranitrate and dinitrate. The latter possesses the characteristic property of becoming milky or opaque when dried from the ethereo-alcoholic solution, and of rendering the collodion film (tetranitrate) opaque also, if present even in very small amount. If therefore any collodion gives a perfectly clear film on glass, it is proof of the absence of dinitrate.

The dinitrate, $C_{12}H_{18}O_8(NO_3)_2$, always occurs as the final product of the action of caustic alkalies (which remove nitric acid) upon the other nitrates of cellulose, and also as the effect of very weak hot nitro-sulphuric acid upon cellulose if carried to the point where decomposition or evolution of red fumes begins, accompanied by solution of the cotton (cellulose).

If plain collodion be treated with caustic potash or ammonia, it passes gradually from the condition

of tetranitrate or pentanitrate, into trinitrate and finally into dinitrate, which cannot be made to give up any more nitric acid; but if the action of the alkali be continued, will be entirely decomposed, forming organic acids and a gum-like matter.

Eder treats a two to four per cent. collodion with an alcoholic solution of caustic potash in about three times the amount necessary to neutralize the existing nitric acid, and after one or two hours dilutes it with water, and neutralizes with sulphuric acid. The precipitated flocculent mass, when washed and dried, is the dinitrate. It is either in the form of gum or powder. Like all precipitated pyroxylines it is hardly inflammable, and detonates at 380°. It is easily soluble in alcohol and ether, absolute alcohol, glacial acetic acid, wood spirit, acetic ether, and acetone; but with difficulty in pure ether. It is also soluble in a mixture of ether and alcohol containing potash, as well as in aqueous solutions of the latter, and can only be precipitated from them by acids (see above). A large part of the dinitrate is always lost when dissolved in an alkaline solution, passing over into a brownish-black gummy mass. The behavior of the ethereo-alcoholic solution, in leaving an *opaque milky film* upon glass, is characteristic; good collodion acquires the same property upon the slightest addition of dinitrate.

Wolfram has pointed out that the dinitrate is gradually formed by the action of gaseous ammonia upon plain collodion containing water.

Some Characteristics of Gelatine.

The melting-point of a gelatine solution lies about 14° or 18° F. higher than its *setting-point.* Both points, however, will be raised in proportion to the excess of gelatine in the solution. But different samples of gelatine will often cause a variation of 14° or 16° F. in the setting-point according to their quality, even when present in the same amount in the solution.

Lessening of the Setting Power.—Cooking, boiling, and long digestion injure the setting power of gelatine. Therefore, in emulsion-making, these processes are not to be continued longer than is absolutely necessary. The presence of acids, fixed alkalies, and ammonia, particularly at high temperatures, likewise impedes the setting. Two per cent. of ammonia, a quantity often used in emulsion, lowers the setting-point from 2° to 4° F., after three hours' heating (Eder). Therefore, ammonia must be carefully used.

Decomposition of Gelatine when Boiled.—According to Hofmeister, gelatine when long boiled breaks up into *semiglutin* (insoluble in alcohol, precipitable by chloride of platinum), and *hemicollin* (soluble in alcohol, and not affected by chloride of platinum). If this breaking-up occurs, the gelatine loses its setting power. Long-continued heating at 86° or 122° F., produces in time an effect like that of boiling. Semiglutin reduces nitrate of silver (and very probably bromide also in presence of ammonia). The breaking-up is hastened by the presence of

ammonia. Under long heating, a process of rotting sets in, accompanied by the formation of ammonia, volatile fatty acids, glycocoll, peptone, and carbonic acid. Ammonia remains in the solution in combination with fatty acids.

Recht examined twelve samples of commercial gelatine; of these, two were alkaline (Nelson, Fisher and Schmidt), and gave off ammonia after three or four days' exposure to heat. The other samples were faintly acid, and after fourteen days' exposure to heat gave off no ammonia, with the exception of one sample of Fisher and Schmidt's, which gave it off at the end of nine days.

Tanning.—The setting power of gelatine is increased by *chrome alum.* One-fifth of one per cent. of this salt will enable the gelatine to set at 2° or 4° F. higher temperature, and render it difficult to melt again. Such additions to an emulsion must, therefore, be made before setting. Chrome alum is much used for emulsions of slow setting power. By Eder's advice, not more than 0.1 per cent. is to be used. (To 500 parts of emulsion, take 5 or 6 parts of a solution of chrome alum containing 20 parts of the salt to 450 parts of water, and from 200 to 400 parts of glycerine, the latter favoring the penetration of the developer into the film.)

Ordinary alum has far less power. As much as ten per cent. may be added without injury (Eder), and the setting thus favored. After the setting has occurred, the jelly may be easily melted again if warmed.

Sulphate of quinia may also be used for the same purpose.

Solubility of Gelatine in Alcohol.—Gelatine is insoluble in alcohol: but by the addition of an acid (organic or inorganic), it may be easily rendered soluble. A solution of one part of gelatine in ten parts of glacial acetic acid, may be diluted with alcohol at will. Eder maintains that gelatine thus treated with acetic acid, retains its solubility in alcohol after neutralization with ammonia.

Mixtures of Collodion and Gelatine.—The practicability of getting gelatine into alcoholic solutions, enabled the author to prepare a mixture of gelatine and collodion. This is done by dissolving photographic cotton in a mixture of alcohol and glacial acetic acid, and mixing it with a solution of gelatine in the same menstruum. If *gelatine emulsion* be dissolved in glacial acetic acid instead of gelatine, and then mixed with acetic collodion, the so-called Vogel's emulsion will be obtained.

Eder gives the following rules for the selection and testing of photographic gelatine:[1] "Two primary requisites in gelatine for the photographic processes proper, such as pigment-printing, heliogravure, lichtdruck, and gelatino-bromide, are *perfect solubility in warm water, and freedom from fatty matters.* The other properties, such as great transparency and clearness of the solution, greater or less setting power, melting-point of the jelly, etc., are not absolutely essential in all sorts of gelatine; for different processes will often require gelatines of the most opposite characters;[2] *e. g.*, gelatine for pigment-print-

[1] A. Moll's Notizen, 188..

[2] Eder, Reaction der Chromsäure u. Chromate auf Leim Gummi, etc., in ihren Beziehungen zur Photo. Wien, 1878.

ing and heliogravure need not be clear, but must dissolve easily in warm water: quick setting qualities being far less important than with gelatino-bromide, where, in addition to this quality, clearness and transparency of the film are imperative. To repeat, then, the tests of gelatine must be applied with reference to the process for which they are to be used."

Practical photographers desiring to test gelatines, should proceed as follows: 1. *For clearness of film*: Gelatine having been divided into small bits and soaked from one-half to one hour in water, should gradually dissolve when warmed in a water-bath, so that neither large masses nor filaments remain undissolved. It is to be remarked that if soaked for too short a time, it dissolves with difficulty when warmed, therefore thickly cut gelatine requires longer soaking than thin, *i. e.*, until it gets perfectly soft. Absolutely transparent samples are rarely met with; but a slight opalescence or homogeneous milkiness, as well as slight yellowness, do not injure the gelatine even for emulsion purposes; and it frequently happens that the firmest kinds are most yellow, because the bleaching process is prejudicial to the firmness of the jelly.

2. *For the presence of fat:* This is a very common impurity in gelatine. Both in the lichtdruck and gelatino-bromide processes it causes spots, because the fatty particles attract the greasy ink and repel the watery developer. To test for fat, dissolve from 600 to 800 grains at least, in 18 ounces of water, and allow the solution to stand in a warm place for several days, keeping it tightly covered. If fat is present, it

will gradually collect at the top in small but unmistakable globules. If its presence is plainly manifested, the sample of gelatine should be rejected, as this will unfit it for any process.

3. *Firmness and hardness:* This (or rather the firmness of the jelly when formed) is of great importance for most photographic processes, and the test may be best effected by means of the Lipowitz Pressure Apparatus, for which Eder has given working directions and tables.

The apparatus and manipulation may be understood from Fig. 5. Exactly thirty-eight grains of gelatine are to be weighed out and placed in a beaker glass one-eighth of an inch in thickness, with one and two-thirds ounces of water; after swelling for a quarter of an hour, the gelatine is to be dissolved by immersing the glass in hot water, and afterwards set aside for twenty-four hours at a temperature of 60°, if possible.[1] The beaker must be kept well covered throughout.

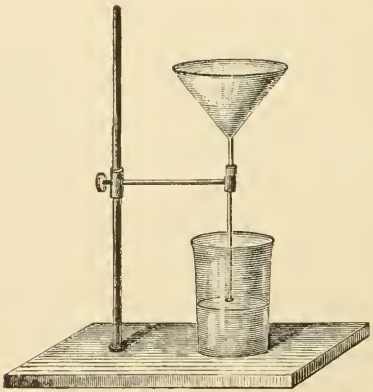
At the end of this time, the mass, which contains five per cent. of gelatine, having firmly set, is brought in the beaker to the apparatus, as seen in the figure, and placed so that the movable rod just touches its surface in the middle. Grains of shot are now poured gradually into the metallic funnel, until it and the rod sink and thus break the surface of the jelly. The addition of shot is then stopped.

[1] For exact testing, it will be necessary to stand the beaker in water at 60° for an hour, before proceeding to the next operation. But for practical photographers, it will suffice if the temperature be near the point indicated, and the vessel placed in a cool place in summer.

The collective weight of the rod, funnel, and shot, is now obtained and noted.

As a general rule, those samples of gelatine capable of bearing the greatest weight are most highly esteemed. "Hard," "strong," "resisting" gelatines are prefered for the lichtdruck and emulsion processes. A gelatine that sets rapidly and

FIG. 5.



firmly is of inestimable value in summer, while good results may be obtained in winter with the softer sorts if otherwise good; when the weather is very cold, too quick setting may cause trouble. For pigment-printing and heliogravure, firmness is of less moment than easy solubility.

A good gelatine when in five per cent. jelly and tested as above, should not give way under less than from 4,500 to 6,000 grains. Soft samples give way under a weight of 3,000, and very firm ones not under 10,000.

The jelly may also be made at ten per cent., and

tested. This is more than double as resistant as the five per cent. jelly, and ought generally to bear at least 9,000 to 10,000 grains. Very firm samples will sometimes bear a weight of six and three-fifths pounds in the ten per cent. jelly.

Generally, the test with the five per cent. jelly will answer.

4. *Swelling in cold water:* The absorbing power of gelatine for cold water when soaked in it is variable. It may be determined by laying a very carefully weighed piece of gelatine in water at 60° for twenty-four hours, then, after taking it out, blotting it carefully off with bibulous paper and weighing.

Good photographic gelatine ought to swell easily, and absorb from five to eight times its weight of water. Generally, this quality is of minor importance in the choice of a sample; still, if two gelatines are equally hard, being good otherwise, it is evident that that one will be preferred for the emulsion and lichtdruck processes which has the least absorbing power. On the other hand, some parts of the photo-galvanographic process where reliefs are taken off, require a gelatine that swells up considerably.

Gelatines that dissolve in cold water are to be rejected.

5. *Melting and setting-point:* This is of the highest importance in the preparation of gelatino-bromide emulsion. If it occurs at a very low temperature, the coating of the plates in summer will be rendered very difficult; a gelatine not melting so easily and setting quickly will be preferable.

A four per cent. jelly should not melt under 82°

or 86°; bad gelatine will melt at 77°. The solution when cooled to 72°–77°, should begin to gelatinize, and set completely at 68°–73°. Bad gelatines will often not set except at 62°–64°.

The same tests may be applied to a stronger (ten per cent.) jelly. This should melt at 89°–93°, and not require less than 72°–79° for setting.

Some care is necessary in accurately determining the melting-point of the jelly. The beaker containing it should be set in a water-bath that is *gradually* warmed. The temperature should advance but slowly from degree to degree. As soon as the jelly is seen to soften around the sides of the glass, the heat is removed, and time enough given to see whether the temperature attained will suffice to melt the remainder. If it does so, a thermometer may be plunged into the melted part of the jelly, and the temperature read off. The heat may afterwards be raised.

To determine the setting-point, the jelly should be entirely melted, and then allowed to stand at the ordinary temperature with a thermometer immersed in it; it may be stirred from time to time by means of the thermometer, to see when the stiffening begins, and the temperature at which the setting begins and is completed thus ascertained.

The easier the solution sets, the more is the gelatine prized for the emulsion process.

6. *Amount of ash:* This should not be large—from one to three per cent. on an average. Still, good gelatines are to be met with containing as much as four per cent. The possibility of the presence of alum (added to harden the gelatine)

should not be forgotten. The test for this is best left to an experienced chemist.

7. *Amount of water:* The foregoing applies here also. At 280° F., the quantity should be from sixteen to nineteen per cent.

8. *Tendency to decompose:* This should always be determined by the photographer. A five or ten per cent. solution in a covered flask is to be exposed to a temperature of 86°–104° for several days or a week. Bad gelatine will rot in from three to four days, giving off enough ammonia to turn moistened red litmus-paper blue; when this happens, it will be found to have lost its setting power. A good gelatine, on the other hand, will not give off ammonia after eight days, and still preserve its setting power, although somewhat diminished.

The jelly may also be set aside at ordinary temperatures, and the time required for rotting noted. This is very variable, but those gelatines that keep best are preferred for emulsion work.

9. *Amount of acid or alkali:* The warm aqueous solution of gelatine may be tested with litmus-paper for acid or alkaline reaction. Those gelatines having an acid reaction are preferred for the gelatino-bromide process, as they give cleaner working plates. It is of advantage also, if the emulsion be prepared at high temperatures or boiled. Acid reacting gelatines are generally clearer too, and are less liable to rot and give off ammonia. The determination of the quantity of acid or alkali is carried out in the ordinary manner pursued by analytical chemists, and is not of special importance to the

photographer. The author believes the acid generally present to be sulphuric.

10. In specially testing a gelatine for emulsion-making, it is best to make a small batch, say of three or four ounces, by the method which is to be used regularly afterwards. At the present time, there are two principal methods, one of which may be called the ammonia process, and the other the gelatino-bromide process without ammonia.

The following experiment will aid in the selection of gelatines for both of the said processes:

a. Mix together in the dark-room 46 grains of bromide of potassium dissolved in 11 drachms of water, and 61 grains of gelatine in a solution of $58\frac{1}{2}$ grains of nitrate of silver in 11 drachms of water. Both must previously be dissolved and warmed. The warm emulsion thus formed is stood in boiling water for half an hour, then half of it poured out into a porcelain bowl and after setting squeezed through canvas and washed. Trial plates are then coated.[1]

b. The other half of the emulsion, after it has been cooled down to 104° F., is treated with 15 drops of ammonia, well shaken, and allowed to stand for half an hour in water at 95°–104°. This emulsion is also to be poured out into a bowl as above, and washed after setting. With this also trial plates may be coated.

When tried, they should be developed by the photographer himself, either with ferrous-oxalate or

[1] For further details, see Theorie u. Praxis d. Phot. mit Bromsilbergelatine. Eder, 1881.

pyrogallic acid, and particular notice taken whether there is perfect freedom from fog in development, whether the developer requires much or little bromide of potassium to secure this point, whether the plate is quite free from the transparent round spots caused by fat,[1] and whether the film when washed after fixing, puckers frills and loosens off, which unfortunately happens with many samples of gelatine. A sample that will stand these tests is fit for all the different processes by which emulsion may be prepared. In large quantities (one or two pounds) it may even be worked with greater certainty, the tendency to fog being less than with smaller batches, which become raised to the boiling temperature much quicker. In general, it will be less easy to find gelatine perfectly suited to the ammonia method than for boiling without ammonia, the same being especially true for hot weather emulsions.

Any gelatine that works well for gelatino-bromide, will also be suited for the iodo-bromide and the chloride emulsions; but the reverse is not always true, for preparation with pure bromide of silver seems to have a tendency to induce fog, which is absent in the case of the other two.

A severe test as to whether a given sample of gelatine is suited to the ammonia method may be made as follows (Vogel): Dissolve one part of the gelatine in ten parts of water, and treat with a solu-

[1] Streaks etc., may come from the gelatine also, yet by increasing the quantity, may be removed. The spots caused by air-bubbles are not to be mistaken for those caused by fat. The emulsion should not be shaken after it has been washed and remelted, so as to avoid the possibility of the bubbles.

tion of ammonio-nitrate of silver (the latter is prepared by adding ammonia to a ten per cent. solution of nitrate of silver until the brown precipitate formed is redissolved). Gelatine after being mixed with this solution, should not color after immersion of the whole in water at a temperature of 104°; if it does, it should be rejected.

If the employment of hard gelatines is followed by a slow development, it is not necessary to reject them if their qualities are otherwise good. A few drops of glycerine will help to do away with the trouble.

11. *Solubility in mixtures of glacial acetic acid and alcohol:* In order to try whether a gelatine is suitable for the numerous so-called "alcoholic gelatine emulsions" now so successfully used, it should be tested as follows:

a. Some of the gelatine is boiled in a test-tube with a mixture of 17 minims of glacial acetic acid and $2\frac{1}{2}$ drachms of alcohol. Many samples will immediately dissolve if they have previously been allowed to swell in the mixture for some time; other samples will only partially dissolve.

b. If the particular sample at hand will not stand these tests, it must at least bear the following: Let 15 or 30 grains swell in cold water; then drain the water off as dry as possible; cover the gelatine with a sufficient quantity of a mixture of 17 minims of glacial acetic acid, and $2\frac{1}{2}$ drachms of alcohol to displace the water, and afterwards add from $5\frac{1}{2}$ to 11 drachms of the same mixture, and warm. Solution should then take place.

The so-called "hard" gelatines are apt not to be

so easily soluble in this mixture as the "soft" kinds. For the latter, a mixture of 17 minims of glacial acetic acid and 1 ounce of alcohol will often suffice to effect solution. It is worthy of mention that this acid solution of gelatine remains soluble in alcohol even after neutralization with ammonia.

CHAPTER IV.

PHOTOGRAPHIC OPTICS.

New Lenses.

Busch's and Voigtländer's Promenade Lenses.—The new forms of pictures, such as the Promenade, Boudoir, etc., have compelled the opticians to produce new lenses adapted to them. Busch of Rathenow, has made lenses working on 7 by 9 inch plates, giving a full-length figure of $6\frac{1}{2}$ inches at 16–18 feet distance. The lens gives excellent definition, and has $3\frac{1}{2}$ inches front and 4 inches back opening. They are well adapted to the purpose, as proved by Reichard. (Phot. Mitth., xviii. 186.)

Voigtländer has produced a Promenade lens of shorter focus working admirably for vignettes and three-quarter lengths. (Phot. Mitth., xviii. 32.) Both objectives are constructed after the well-known Petzval model.

Voigtländer's new Portrait Lens.—This has a front combination similar to the old Petzval. But the back combination consists of two single lenses cemented, by which the reflection of light occurring in the old form with separated lenses is avoided. The focus of these lenses is relatively shorter than that of the old form with similar opening. For instance, Voigtländer's *C* lens, by substituting the new back combination, has its focus shortened from

10 inches to 7½ inches, thus increasing the illumination in the proportion 9 : 16. The new back combinations may be bought separately, so as to be used with any lenses by the same maker. We thus have the power to shorten or lengthen the focus, and correspondingly increase or lessen the light at will, by using the new form of back combination. (Phot. Mitth., xv. 211.) Another construction by Voigtländer, not yet in the market, is described in the Phot. Mitth., xvi. 281.

Steinheil's Antiplanetic.—This is a portrait lens lately constructed by Dr. A. Steinheil of Munich, after a long series of calculations. It is entirely different in principle from Petzval's. The patent description of it speaks thus:

"It is by no means difficult to make photographic lenses which give straight lines: nevertheless, the definition will be found to give way from centre to edge more or less, according to the perfection of the instrument. Improvements in this respect demand a totally different form of construction."

"After calculations occupying some years, the inventor has found that an objective consisting of two combinations (doublet) possesses this fault in a less degree the more unequally the work performed by the objective is divided between its combinations. In the case of the antiplanetic (*αντι*, against; *πλαναω*, I deviate; thus composed of two halves, with faults opposite in character) objective now under consideration, its two combinations possess faults of a very marked but opposite character, and while the one has a shorter focus than the objective as a whole, the other has a negative focus."

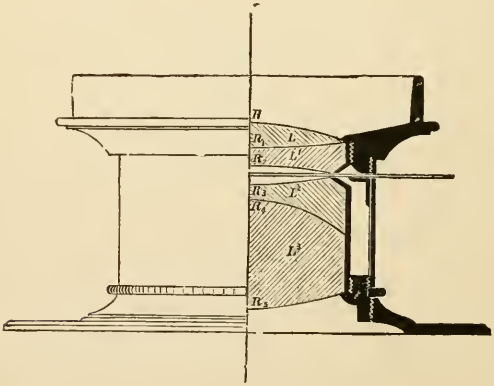
"These lenses are made in two styles, according to the class of work for which they are to be used:"

"1st. For open-air work, such as groups, landscapes, etc., where on account of the danger of reflection, not more than two separated combinations (four changes of medium for the ray, *i. e.*, from the air to glass, and back twice repeated) are allowable; the same reasons requiring that the combinations be cemented."

"2d. For portrait taking in the studio, where a large opening in proportion to the focal length is the principal desideratum, it being here permissible to separate the lenses of one combination."

"1 *a*. The Antiplanetic for groups, to be used in the open air, has an opening of $1\frac{3}{4}$ inches with a

FIG. 6.



focus of $9\frac{1}{2}$ inches. The front combination consists of a biconvex flint-glass lens, L, cemented to a biconcave crown one, L^1, the whole having a focus of

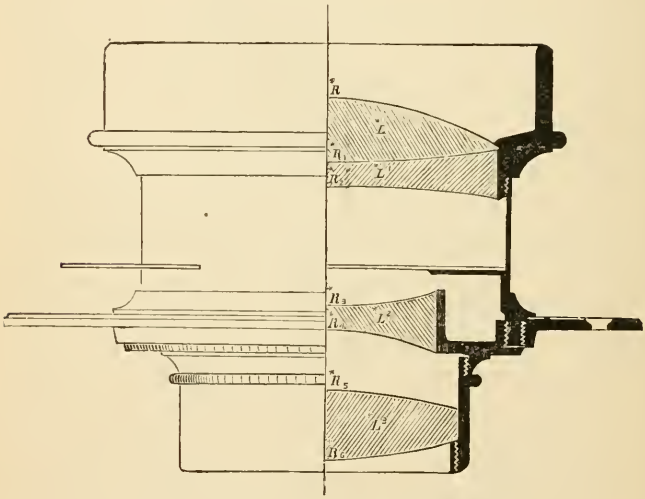
about $8\frac{5}{8}$ inches, and great chromatic and spherical aberration, together with distortion of the same kind as that given by a single positive lens. The back combination, standing at a very short distance from the front one, consists of a biconcave flint-glass lens, L^2, cemented to a biconvex crown one, L^3, and has a very long negative focus, together with spherical and chromatic aberration just as great, but of the opposite kind, so that it nullifies the other."

"Figure 6 shows this lens partly from the outside, and partly the internal arrangement."

"2*a*. The Antiplanetic for portraits, to be used in the studio, has, with the same focal length, a front combination of 3 inches focus; the back combination consists of two separated lenses of unequal size—a flint-glass one, $*L^2$, of $1\frac{7}{8}$ inch diameter, and a crown, $*L^3$, of $2\frac{5}{16}$ inches diameter. The front combination, in which the first radius is very short, has a positive focus of about $6\frac{1}{4}$ inches, and consists of a biconvex crown-glass lens, $*L$, cemented to a biconcave flint one, $*L^1$, and has great chromatic and spherical aberration and distortion of the character of a single positive lens. The back combination, standing at the distance of about one-third of the diameter of the front combination, is composed of a biconcave flint-glass lens, $*L^2$, and a biconvex crown one, $*L^3$, which latter stands at the distance of about one-fourth the diameter of its own opening from $*L^2$. This back combination has a negative focus of about 31 inches, together with great spherical and chromatic aberration and distortion of the negative character, so that it nullifies the corresponding faults of the front combination."

Obernetter has used the Group Antiplanetic with great success for his instantaneous work. It is not rapid enough for the studio, inasmuch as the proportion of opening to focus (about 1 : 6) is not much

Fig. 7.



greater than that of the ordinary Aplanatic. According to Schaarwächter, the Group Antiplanetic requires 10 seconds' exposure, while the Aplanatic requires 12. (Phot. Mitth., xix., June.)

Steinheil's Landscape Aplanatic is an instrument resembling the Ordinary Aplanatic in construction. It contains two similar symmetrical achromatic concavo-convex lenses like the latter, and gives equally straight lines, but has a smaller opening, and is slower, so that, under parallel conditions, the Landscape Aplanatic requires double the exposure of the

ordinary form.[1] But it has a much wider angle of view. In the case of a Landscape Aplanatic of $\frac{1}{16}$ inch opening, the angle of the diameter of the circle of light was 91° 40′ (the old form giving only 67° 40′ when measured in the same way). The working field of the lens was smaller of course; covering an angle of 64° with a $\frac{5}{16}$ inch stop, while the old Aplanatic gave only 52° with the smallest stop. In like manner, the instrument with smallest stop and focus of $9\frac{5}{8}$ inches gave a picture of 12 inches in length ($1\frac{1}{4}$ times its focal length), and sharp enough for architectural subjects. The old Aplanatic gives sharp pictures whose length under similar circumstances is equal to that of its focus. Thus the instrument is adapted to those classes of work where freedom from distortion is required (given also by the old form), but where in addition, a wider angle becomes imperative. It ranks between the Ordinary and the Wide-Angle Aplanatic; Busch's Pantascope occupying also an intermediate position.

If the results given by these lenses are placed in tabular form, we will have as follows (see Phot. Mitth., 15th year, 292):

	Diameter.	Focus.	Length of picture with smallest stop.	Visible field.	Working field.
Old Aplanatic, No. 4,	$1\frac{5}{8}$ in	$11\frac{1}{2}$ in.	11 in.	67° 40′	52°
Group Aplanatic,[2]	$1\frac{3}{8}$ "	$7\frac{1}{4}$ "	8 "	70°	59° 30′
Landscape Aplanatic,	$\frac{5}{8}$ "	$5\frac{5}{8}$ "	12 "	92°	64°

[1] Thus the Ordinary Aplanatic, No. 4, has the relative opening $\frac{1}{7\,8}$, and the new one $\frac{1}{10\,5}$. The squares of these figures will give the relative intensity of the light. It is evident that this is true only for those of the instruments already tried; smaller ones frequently having relatively greater intensity of light, and the larger ones less.

[2] This is no longer made by Steinheil, the Group Antiplanetic having supplied its place.

Steinheil's Wide-Angle Aplanatic.—The No. 2 style of this instrument with the cap on has much the appearance of an Orthoscopic of about 2 inches diameter: but, on a close examination, it is surprising to find that the lens is not larger than a large pea ($\frac{1}{4}$ inch). In the author's hands, it gave a picture 7 by 9 inches, with an angle of over 90° sharp to the edge. The circle of light was much larger: with a focus of scant 5 inches, it could not be seen on a plate of 15 inches in length. The exposure is about the same as that for a Pantascope. This instrument also, may be focussed with comparative ease, and is free from the central spot or ghost.

Voigtländer's Quick Euryscope.—This instrument is similar to the old Euryscope in construction. (Lehrbuch, iii. 220.) Its form, dimensions, and stops are just the same, but the focal length is decidedly shorter, and the power of light and angle consequently increased, so that pictures just as large may be made with the new lens as with the old. The focus of the old No. 2 Euryscope (of $1\frac{3}{4}$ inch opening), for example, is $13\frac{1}{4}$ inches, while that of the new lens of the same size is only 10 inches, and the power of light stands as the squares of their foci inversely. The result of the author's trials was that the new instrument would perform in 10 seconds what the old form required 17.5 seconds for. The definition is irreproachable. Further, the lens covering just as large a plate as the old one, but having a shorter focus, the visible field is larger with respect to the working field than in the case of the latter.

Mr. Prümm tried a large one (No. 5), of 3 inches

diameter, and found it $1\frac{1}{2}$ times quicker than the old Euryscope. He gives it the highest recommendation for portraits.[1] The same gentleman, in comparing it with the ordinary portrait lens, speaks as follows: "Compared with a 3, 4, or 5 inch portrait lens, the exposure for the new Euryscope, with full opening, had to be about $\frac{1}{4}$ or $\frac{1}{3}$ longer, but the sharpness was much greater. If the same definition was required from the portrait lens, a smaller stop would have to be used, and in that case the Euryscope would be quicker."

Voigtländer's Euryscope for Landscapes.—This is a symmetrical lens, and resembles the Aplanatic and Euryscope. The stops run from $\frac{3}{16}$ to $\frac{7}{8}$ inch in diameter. The lens has a focus of $12\frac{5}{8}$ inches, a visible field of 90°, and a working field of 80°, covering a 14 inch plate sharp to the edge. In this respect then, it is superior to the ordinary Euryscope but not to the Pantascope, which is well known to give sharp definition over an angle of more than 90°. The instrument is perhaps $\frac{1}{3}$ as quick as the Aplanatic, and consequently quicker than the Pantascope. It can be focussed with full opening, and bears a resemblance to Steinheil's Landscape Aplanatic (see page 102; also, Phot. Mitth., xvi. 109, and xvii. 266).

[1] Messrs. Schaarwächter and Reichard say the same. (See Phot. Mitth., xviii. 211.)

Artificial Light and its Application to Photography.

The relation of magnesium light to the electric was determined by the author by means of his scalen-photometer. A Siemens' light of 800-candle power, without reflector, produced the same effect in 2 minutes at a distance of 7 inches as 366 grains of magnesium wire at the same distance. The light from a Bunsen battery of 50 cells showed feebler action, being about $\frac{7}{11}$ of the Siemens' light. (Phot. Mitth., xvi. 187.)

The Luxograph.—In place of the costly magnesium wire, an attempt has been made to re-introduce Bengal white fire. It is burned in a blue glazed lantern with chimney, the whole standing in the focus of a concave reflector of about 4½ feet in diameter. The reflector is at about the height of the head of the operator and directed downwards towards the sitter; it consists of a large number of small bits of looking-glass set together like mosaic. The mouth or opening is covered with fine tissue-paper to moderate the light which would otherwise be too crude. Gelatine plates (extra rapid) are used. Focussing is effected by means of a row of gas-jets arranged over the reflector; after it has been attended to, an assistant lights the mass in the lantern, and so the exposure is made. About 5 seconds is the usual time for gelatine plates.

The whole affair is simple and portable. Alden, the inventor has had frequent orders to take the apparatus to halls where large masked balls are given. Having taken his position in a small room

near the ball-room, he was enabled to take portraits in fancy dress throughout the night.

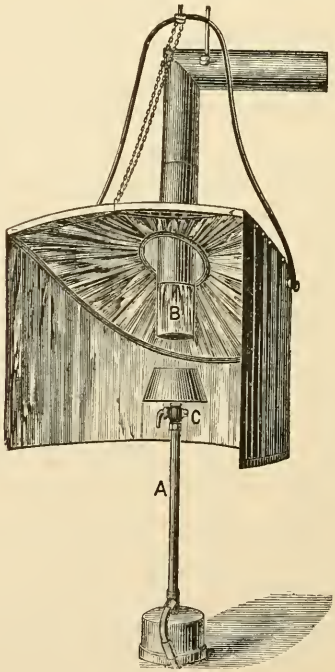
Many persons who would like to be photographed in fancy costume complain of the inconvenience of carrying their dresses to the photographer's during the day hours, and being compelled to put them on there; the difficulties in the way here are often serious ones; nothing on the other hand can be easier than to step out of a ball-room for a few minutes into an adjoining one where the Luxograph is in readiness to make the portrait on the spot. The Luxograph will certainly serve this and other purposes very well.

The results seen by the author were not equal in quality to those made by the electric light or daylight.

Photography by Gaslight.—Mr. Law, of Newcastle, has been taking portraits by gaslight with excellent success for some time; gelatine plates of course being used. His apparatus consists of a very powerful burner and suitable reflector. It is arranged as follows: The burner stands on an iron rod with a foot *A*, 4 feet 6 inches high. Over the round burner is a chimney whose lower end *B*, is made of mica which is not affected by heat. A cock *C*, serves for controlling the flow of gas, being so arranged that the flame is not entirely put out on being turned down, but continues burning. The burner is made after Wighan's model; it contains 68 openings, and gives a light of 1250-candle power(?). A Siemens' (Dresden) generative burner would do the same and these are manufactured up to 1000-candle power.

The reflector is made of galvanized iron and strips of silvered glass; the top part gives the top light, and the side part the side illumination. It hangs on an iron rod by which it may be turned in any direction, and its width in front and the height of its sides are forty inches. When about to be

FIG. 8.



used, its upper part stands about six feet from the ground. A burner of this power so close to the sitter is disagreeable, the light and heat being felt. To modify this, Law erects a screen of blue-glass

between the apparatus and the sitter, measuring about 40 x 40 inches; this cuts off about one-fourth of the light. The exposure for a carte-de-visite is eight seconds, and for a cabinet twelve or fifteen.

Photography with Electric Light.—Efforts to photograph by electric light have been lately so very successful, owing to the improved forms of battery and the methods of regulating the light, that it may be said now to have a regular place in photographic practice. There are electro-photographic studios in London, Paris, Berlin, and St. Petersburg, in which not only portraits are made, but reproductions also (in Siemens' establishment, and at the General Staff Office, it is used only for this purpose), and for making enlargements (Ph. Graff, Berlin; Winter, Vienna). Its usefulness will increase as its price becomes lower. At present the outlay for the machinery is still large, as it requires a dynamo-electric machine with direct current, and either a steam or gas-engine as the motor, wire connections, regulating apparatus, etc. The advantage in the use of the electric light is that *the operator is quite independent of the weather, and can work at night; that any room without windows or on the ground floor can be used for the studio, and that the exposure is more under control than it is in the constant variations of daylight.* Special studies of lighting may be made just as easily as by daylight. Of course, some previous experimenting must be gone through with in order to become familiar with the working of the light.

The chief advantages of the electric light are its evenness, its white color, its powerful actinism, and its enormous intensity. No other known means

will give white light of 4–12,000 candle power. This intensity indeed is only of value photographically in one respect, in others it is a disadvantage. It is useful for lighting objects in still life—pictures, interiors, enlargements, etc. (for the latter, the power of concentrating the strong light in a small space or almost a point, is very valuable): but it is bad for lighting the living model, the direct rays of the blinding light causing involuntary distortion of the facial muscles, and making crude lights and heavy shadows. Even for non-photographic purposes, such as the illumination of museums, large stores, streets, in a word, for any place having a large concourse of people, this hard, crude light is painfully felt, and therefore has been used in exceptional cases only.

The electric light only became endurable and finally popular, when the manufacture of medium power lights of 200 candle power was undertaken, instead of the powerful ones of 4,000 and over. This applies to street lighting and portrait photography. But this modifying of the power for both uses was aimed at in different ways. In the case of streets and stores, by substituting several lamps for one, by which of course a number of weak lights are obtained instead of a single powerful one—not without considerable loss of power however.

Thus for example, a Siemen's dynamo-electric machine with four-horse power motor (as used by Ronzelen, of Berlin), gives a 4,000 candle-power light with *one lamp*, and with four lamps about 800 (each lamp 200). But lights of this power especially when protected by ground-glass globes (which

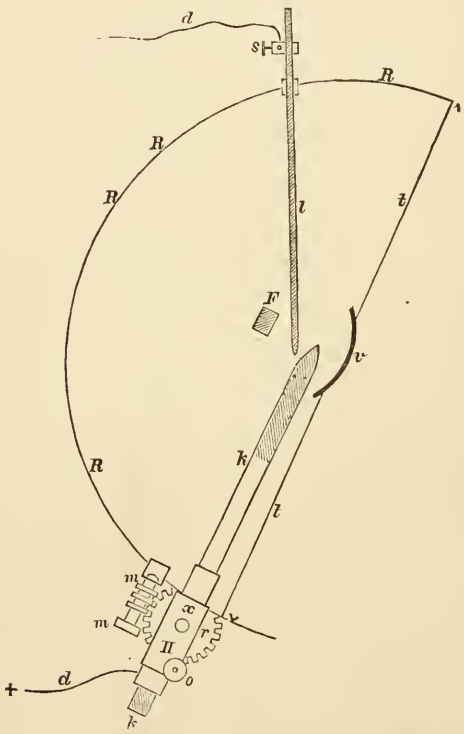
indeed absorb one-third of the light), may be borne by any one without disagreeable sensations. In photography however, the modification of the light is attained in another way. Here a broadly spread and *diffused* light is required, in order that the sitter may be dealt with in an artistic manner.

Instead of a number of different points from which the light proceeds, a broad surface in the form of a concave reflector, is illuminated with one powerful 4,000-candle power light. This is the Van der Weyde system, hitherto recognized as the best for portrait purposes.

R R (Fig. 9) represents a semicircular reflector made of copper lined inside with paper and five feet in diameter. Through its walls are passed the carbon points *k* and *l* (insulated by means of rubber tubing), connected with the electric machine by wires, *d d*, + marking the positive, — the negative pole. A regulator for moving the carbon points is not seen in the figure. This is done by hand, and is quite sufficient for the purpose, as the light is only used for a very short time (a few minutes). The upper carbon point *l*, is of less diameter (five-sixteenths of an inch) than the lower one (three-fourths of an inch). Both are arranged in holders permitting sliding movements, which in the lowermost is effected by a simple rack and pinion adjustment, just like the lens movement; an ingenious method of lowering the point *k* is seen in the figure where the holder *H* is situated on a movable axis *x*, which carries a small toothed wheel *r*, in which the endless screw *m* engages. When the screw is turned, so is the wheel *r*, and likewise the holder

carrying the carbon point k, this being now so easily moved that it may be made to touch the lowest point of l. The electric current is then turned on (Fig. 9). If $m\ m$ be turned so that the point k

FIG. 9.



separates from l, the electric light is generated between them. Slow consumption of the carbon now goes on (more marked on the side of k positive pole, than l). Finally, a hole or depression is formed

on *k*, and the distance between the poles is thus increased, and if allowed to continue, will extinguish the light owing to the inability of the current to spring over the gap. To prevent this, the operator looks at the light through the red glazed window *F*, and regulates the position of the points by turning *m* and *o*. This can be done without strain on the eyes.

V is a metallic reflector supported on the wires *t t*, that prevents direct rays from falling on the sitter, and throws them back to the reflector *R*.

It may be easily seen that this arrangement is simple enough. Mr. Hefner, of Alteneck, the electrician of Siemens and Halske, does not approve of this model, deeming it better to arrange a self-acting regulator with clock-work on the reflector, since irregular adjustments easily cause derangements in the dynamo-electric machine.

This form, recommended by Hefner, is used in Van Ronzelen's studio in Berlin. Here also the source of light is near the middle of a semicircular reflector hanging from the ceiling, and in general arrangement is much like Fig. 9. The reflector however, is more curved than that in Fig. 9, and is varnished with a matt surface. A defect in the apparatus is that the regulator is immediately under the source of light, so that its bulk cuts off part of the reflecting surface; besides, it is not opposite the middle of the screen (reflector), but hangs perpendicularly down before it on wires, thus being nearer to or farther from the middle, according to the direction given to the screen.

We should consider a preferable form to be one in

which the regulator was brought below the reflector somewhere near the wheel-work *m o x*. Failing this, we prefer the Van der Weyde apparatus (Fig. 9).

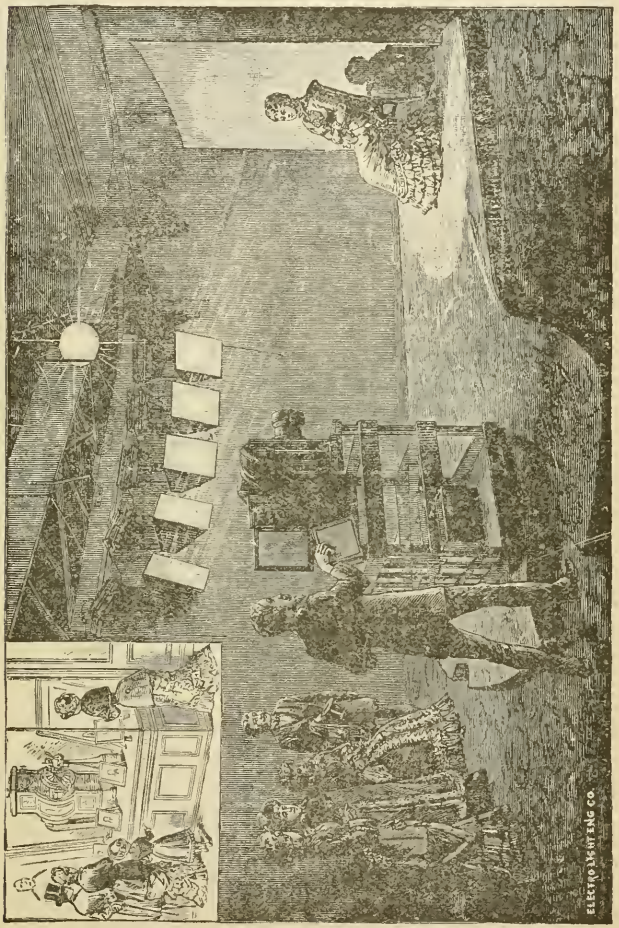
The method adopted by W. Kurtz, in New York, is directly opposite to Van der Weyde's. Instead of permitting the light to control him, Mr. Kurtz controls the light, and causes it to be distributed over the sitter at various angles to suit his will. By the method already described, it is understood that the light must be moved about from place to place, in order to secure a proper effect in the negative. Here, however, the lights are stationary, or substantially so, and the sitter is moved about underneath them by a method which will be described further on. No description could make Mr. Kurtz's method more plain than Fig. 10.

The position of the light as related to the sitter is here shown, and that of the camera and operator as well. However, this is only so a part of the time of the exposure, for by means soon to be explained, the sitter is moved about under the light upon a platform which revolves, upon which the camera and background also stand. Here certainly is not only an invention, but great progress.

By means of a lever attached to the end of the platform where the operator stands, the platform is moved from one place to another, and the resulting picture is all that could be desired. The effect of the lighting upon the subject is very beautiful, possessing softness and delicacy equal to that of an ivory miniature. Mr. Kurtz uses five or more electric lamps suspended from the ceiling in proper place.

He compels them to follow his bidding, and drives their light wherever he desires to secure his results,

FIG. 10

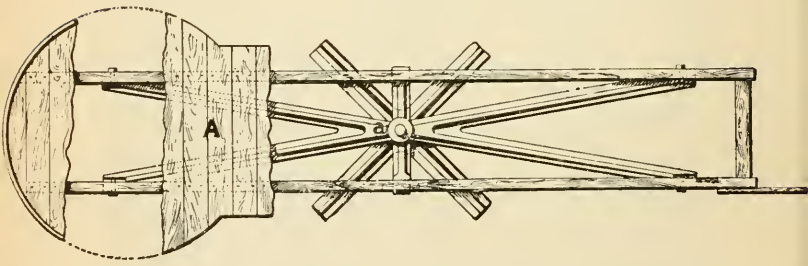


and all this without the least heat whatever from

the lights. No skylight is used, but an ordinary room, which might be the interior of the king's chamber of the great pyramid, for all that. Any room will do, so that the proper amount of light is secured, and the other necessary arrangements are supplied. This method, however, could not be used without the application of Mr. Kurtz's second invention, which he calls his rotating platform. The figures below represent this apparatus so that they may be understood by the reader.

Fig. 11 is a lateral view of the arrangement

Fig. 11.



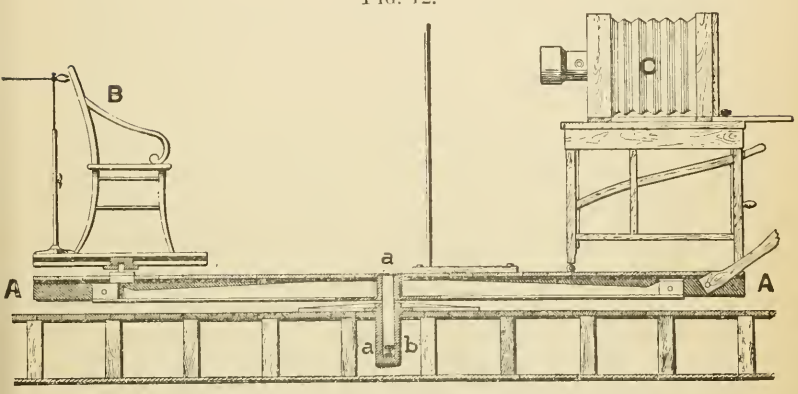
showing how the iron and wood parts are constructed.

Fig. 12 is a vertical sectional view of the platform and apparatus.

The platform, *A A*, revolves on the axis *a b*, the centre being at *a*. The head of the sitter is supposed to be at *B*; the rest is readily understood. The operator, standing as seen in the large cut, arranges his subject. The light is always ready, and during the exposure, by means of a lever, the platform is so moved within a circle as to subject the model to various lightings.

At first, this method of lighting would seem absurd, but a further explanation will prove that *this* time practice is contrary to theory. We are all familiar with the method of printing practised some little time ago called mezzo-tint, whereby the introduction of a transparent medium between the negative and the print secured a soft or ivory-like ap-

FIG. 12.



pearance to the print. Why, argued Mr. Kurtz, should not this be the case when making the exposure? Undoubtedly it can be so if the proper *medium* can be found. Why should not *air* in a state of vibration serve as that medium? With this thought he went to work, and has actually proven that his guess was correct.

Now we come to the platform. It is ten or twelve feet in length, by any width that is sufficient for the purpose, and capable of sustaining the weight of six hundred pounds. It is so balanced on the central pivot at a height of about fifteen inches from the ground, as to allow of its being pushed

around the circle without the slightest effort and without a jar. As shown in the figure, at one end of the platform is the camera, and at the other the sitter.

The model having been posed in the ordinary way, the operator should stand behind the camera, revolve the platform from one-quarter to the half of the circle, thereby bringing the sitter from one light into another at his option. It is evident, that while the sitter remains perfectly still, the lights and shadows on his face are constantly changing and moving, without the use of reflectors. This constitutes the central principle of Mr. Kurtz's invention. At once the practised operator would say, "why the result must be an almost unshaded, misty, flat, Chinese sort of a picture." But the theory does not coincide with practice, as will presently be shown. Let a watch-dial be imagined, and a line running from figure 6 to figure 12 across the dial represent the line travelled by the ends of the platform. On the left, imagine the window of the studio. Now if the sitter is placed at figure 12, it follows that the camera will be at figure 6; and if the camera is moved from 6 to 9, the sitter will be found at 3, and so on. This is the theory of the whole thing.

Now, just as certain chemical substances are so acted upon by the rays of the sun as to enter into new combinations, or to separate entirely into their component elements, so light is acted upon by the effect of motion. This is the principle of Mr. Kurtz's vibratory method of lighting. To photographers, a further explanation is hardly necessary. A little more, however, concerning a further point.

A strong high-light affects the chemical substances used in photography much more rapidly or powerfully, comparatively speaking, than a mellow, diffused, or half-light. If the process went on with equal rapidity all over the plate, the chemical substance would be one-half destroyed in the half-lights at the end of a given time; one-quarter in a quarter, and so on. This, however, is not the case in practice. While the full-light exerts its full effect in ten seconds, the half-light being more feeble, may require fifteen seconds to exert its full effect; the quarter-light twenty seconds, and so on. If, therefore, the quarter-light is put first at its full force, necessitating an exposure of twenty seconds, the half-light, which ought to stop at fifteen seconds, will have to be over-exposed for five seconds; during which five seconds it continues to work on the chemical substances still undecomposed, and the result is a falsification of the gradation as pertaining to the contrast between light and dark, and a tendency to destroy those middle tones which give unity and artistic beauty to the picture. But the difficulty is still further complicated by the following fact. The effect produced by a given light in say, ten seconds, is not duplicated by another exposure of ten seconds to the feebler light of greater extent. For example, a strong light acting upon the plate probably produces fifty per cent. of its maximum effect in its first two seconds; twenty-five per cent. while in the third second, and the remaining twenty-five per cent. in the five seconds left. The full effect then having been reached, that is to say, the decomposition or change of the chemical substances

having been completed, the process stops. With a half-light the case is different. Fifteen seconds being needed for the production of its legitimate effect, twenty-five of its fifty per cent. are perhaps affected within the first three seconds, one-eighth in the following five seconds, and the other eighth in the remaining seven seconds. But here the process does not stop. While the quarter-lights were still lower, the half-light goes on increasing in brightness, as previously explained, although, in an inverse ratio to the length of time. That is to say, they go on with a constantly decreasing rapidity.

Remember then, first, that the high-lights act more rapidly. They take hold of a plate more suddenly than lower lights; and, second, they therefore accomplish their full results in comparatively less time than lower lights. Third, photographic action decreases in the inverse ratio to the length of exposure.

I need not go further. The thinking photographer will at once understand the theory of Mr. Kurtz. I believe that it is a correct one. In the hands of an experienced operator, the revolving platform is a useful thing for the production of artistic effects in endless variety. One can begin with the high-lights, and let the shaded parts develop afterwards, or he can flash in the high-lights at the last moment. He can produce all the contrasts that he desires, and get Rembrandtistic effects, with concentrated lights, or softly rounded pictures, delicately modelled, in a diffused light. At the same time, there is no fear that the inexperienced operator may work harm with it. On the contrary, it will compel him to do better

work in spite of himself. May we not expect, then, from Mr. Kurtz's method, better portraits with more ease and in less time than by the still method—portraits which will need little or no retouching, distinguished by greater rotundity, softness, and richness in the middle tints—thus combining all those artistic qualities which the photographer has hitherto lacked, and which all previous attempts in the same direction have failed to attain? Let us hope so.

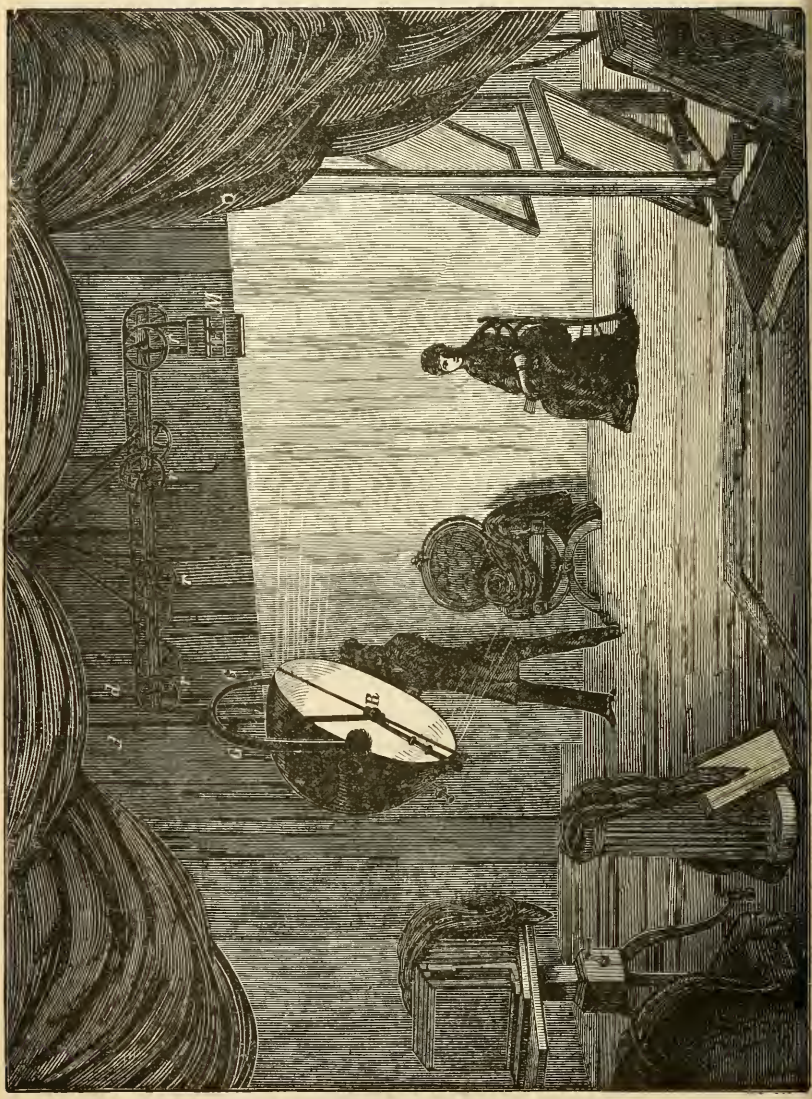
The arrangement of the Van der Weyde electro-photographic studio is shown in Fig. 13. The reflector and light hang by a sort of fork, *G* (capable of motion on a horizontal axis), on a horizontal iron rod, balanced by weights at the right, and turning on an arm let down from the ceiling. The weights hang by chains passing over rollers and connected with the reflector and fork. By this means the former may easily be raised or lowered.

The excellent results obtained by the inventor, and afterwards by Levitsky, of St. Petersburg, speak well for the apparatus.

If merely copies, enlargements, or any objects of still life are to be photographed, such a reflector is not necessary. The direct rays of the light may be used. This is seen in the photographic rooms of Siemens and Halske, which are devoted entirely to the photographing of machinery, models, and drawings; also in the copying-rooms of the Imperial Staff in Berlin.

In all these studios, together with many others, the powerful Siemens' light of 4–5000-candle power is used. Attention has also been repeatedly directed

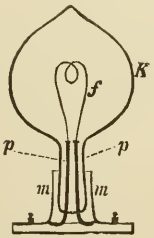
FIG. 13.



to a new form of electric light known as the Swan lamp—an invention of the same Swan whose name is well known from his efforts in carbon-printing.

This Swan lamp is based upon quite a different principle from the ordinary electric light. It is well known that platinum wire becomes incandescent if a sufficiently strong electric current be passed through it. Draper, in 1847, tried to utilize this for illuminating purposes. The difficulty is that the wire easily melts if the current is too strong. King, therefore, took carbon rods in place of platinum, and, as these burn up quickly in the air, he enclosed them in a vacuum. This old form of King lamp may be called the prototype of the Edison, Mawson and Swan, Siemens, etc. In these, the carbon is so thin that it may be called wire.

Fig. 14.



All three forms resemble each other; they consist of a glass vacuum globe, *K*, slightly smaller than the closed fist, containing a fine carbon rod, *f*, made of a strip of cardboard pressed between red-hot plates of iron. These are supported on platinum wires, *p p*, melted into the substance of the glass foot of the ball, and connected with the metallic

conductors, *m m*. If the terminal wires of a sufficiently strong battery (at least eight zinc-carbon cells are necessary) are connected with *m m*, the current passes through the carbon rod, *f*, and causes it to glow. The light so obtained (with a strong enough current) is about equal to a good Argand gas-burner (about twenty candles), and might very well be substituted for gas or petroleum.

Pritchard has lately published a series of experiments intended to prove the applicability of the Swan lamp to photographic purposes, but which do just the opposite. (News, Nov. 18.) Four of these lamps were connected with a battery of 30 cells (platinum-zinc), *i. e.*, at the rate of $7\frac{1}{2}$ cells to each lamp, and the light of each one tested with a paper photometer (like Vogel's), having under it a gelatine plate which was afterwards developed with iron. The fish-tail gas-burner, consuming 5 cubic feet of gas per hour, was also tested in the same way. The result was that the light from the Swan lamp developed the figure 9, while the fish-tail burner gave the figure 7. If the opacity of the photometer paper used by Pritchard was known, the relation between the Swan light and gas might be calculated. (According to the above experiment, Vogel's photometer paper would have given the ratio of illumination as 1 : 1.6.)

Pritchard proved that the illumination was increased if the current was made to feed a diminished number of lamps. For example, with three lamps tested as above, the light from one brought out the figure 14, the light from two the figure 18, and when a single lamp was used with the full power of

a 30-cell battery, the figure 23 appeared. But an ordinary regulating-light used with 30 cells gave a much greater illumination, the figure 25 appearing, and the action having even extended beyond. It is clear then, that with equal intensity of current, the actinism of the Swan lamp even under the most favorable circumstances, cannot equal that of the ordinary electric light (Kohlenlicht).

Siemens has just declared that the Swan light is still too expensive. Besides, the carbon gradually becomes broken down and colors the gas yellow (?). Swan's agents claim that the globes keep for eight months; others, that they are not to be depended on for more than four months.

The author is sure that successful photographic efforts may be made with this light, but he is also of the opinion that the same efforts may be made with other forms of artificial light, and at less expense.

Thus we may say that for photographic requirements, the ordinary electric light is the only form. Its practicability may be easily demonstrated, but it must also be admitted that those desiring to work with it must familiarize themselves with its peculiarities.

Secondary Batteries for Electric Light.—The large expense of a special engine for the electric light has lately led to the application of various forms of battery for the purpose. The attention required, however, as well as the expense and uncleanliness, has not until recently made them favorites. But a new form of electric battery is commanding attention, and is free from the defects complained of. It is the so-called Planté battery, which can be obtained

ready for use, "charged," as it is said, and requiring no troublesome amalgamation of zinc plates, nor handling of corrosive acids. These batteries are sold in France, England, and sometimes in Germany, and in the former countries are very commonly employed both for galvano-plasty and feeding the Swan lamp. For photographic purposes, they are only useful when required for a short time, as, *e.g.*, for enlargements.

The Planté battery consists essentially of a number of vessels, each containing two leaden plates immersed in weak sulphuric acid. Such cells are powerless in themselves, but are made to act by bringing one of the plates into connection with the positive pole and the other with the negative pole of a galvanic battery. Decomposition of the water is thus set up in the cell, together with oxidation of the positive lead plate, which thus becomes powerfully excited, and a current is started if the two lead plates be united by a connecting medium, keeping up until the nascent hydrogen has fully reduced the coating of oxide of lead on the plate. This coat has a thickness proportionate to the time the cell was allowed connection with the battery. When a number of such cells are connected together, the current is strong enough to create a powerful light. Fifty cells will be required for this purpose. Our own experiments have been made with 60 of the Bunsen cells (zinc and carbon). It is claimed that the Planté cell is 1½ times as strong as the Bunsen; accordingly, 40 of the former would equal 60 of the latter. The light from 60 Bunsen cells is not strong enough for portraiture; the author estimates (by the means

mentioned above) that it has about 500-candle power. This will answer nevertheless for enlargements.

It must be mentioned, however, that the strength of the Planté battery rapidly decreases. If it is freshly charged, let us say at 100, it would fall to 92 on the following day, the third day to 79, the fourth to 34, the fifth to 24, the ninth to 8 (Gladstone and Tribe). The older the cells are, therefore, the greater the number needed.

Sutton describes a peculiar form of secondary battery, saying that it is as powerful as it is practical and economical. It consists of an amalgamated lead plate and one of copper, plunged into a solution of sulphate of copper. Great advantages are claimed for the amalgamation of the lead plate. The latter is connected with the negative, and the copper plate with the positive, pole of a battery. The sulphate of copper solution (which must not be saturated, but have an acid reaction) becomes decomposed. The lead becomes peroxidized while the copper goes to the copper plate. As the decomposition proceeds, the solution loses color.

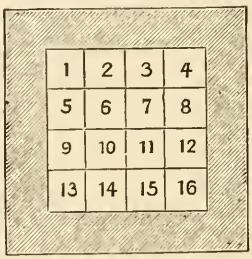
When the battery is charged, the copper becomes the positive and the lead the negative pole; during the passage of the current, the peroxide of lead loses oxygen, and the copper is redissolved. The progress of the decomposition may be known from the blue color of the solution.

Sutton also tried zinc for the positive plate, immersed in a solution of sulphate of zinc. The plate had to be amalgamated in every case. This he deems an inconvenience; but the electro-motive power is decidedly greater when zinc is employed.

Chemical Photometers.

Warnerke's Sensitometer.—This instrument is intended to fix the sensitiveness of negative plates. In general principle it resembles Vogel's photometer (Lehrbuch, 175), except that the scale is made by relief-printing. Fig. 15 shows its arrangement,

Fig. 15.



with the figures 1 to 24, which increase in opacity in geometrical ratio.

Warnerke claims that the scale can be made much more even by means of the Woodburytype than by tissue-paper, whose uniformity cannot always be depended upon, and which also becomes yellow with age. This does not matter for pigment-printing, but interferes with the more accurate requirements of dry plates. The method of exposure is interesting, and Warnerke uses a normal light for the purpose This consists of a glass-covered tablet painted with luminous paint. An inch of magnesium wire is burned before the tablet; the latter allowed to stand for a moment, and then laid over the scale, underneath which lies the sensitive plate. War-

nerke believes the light thus obtained to be always regular. This was not the author's experience, temperature having such an effect on the illuminating power of the paint that very variable results were given; he obtained the figure 20 with a warmed phosphorescent plate on an emulsion plate, but with a cold one only the figure 19: thus the variation was 25 per cent. For the rapid increase of the degrees, see next page.

The instrument is somewhat like a small printing-frame. In it lies the transparent scale printed on glass, instead of the ordinary plate glass. Above it is a light-tight shutter like those of negative holders. The luminous plate is laid above this, and the apparatus having been carried into the dark-room, the shutter is drawn a minute after the luminous plate is excited. The sensitive plate is then taken out and developed. It is essential that the same developer, at the same strength, and if possible at the same temperature, be used, and its action allowed to continue for a specified time. For the reading off, see page 140.

Vogel's Tube Photometer.—Photometers in which a semitransparent paper scale is used, have a disadvantage not of much account when used for printing, but in testing the more sensitive negative plates a great source of error. The strength of light under the different figures increases by rapid intervals, and in geometrical ratio to the number of layers of paper. For example, one layer of ordinary eight kilo. photographic paper will absorb four-fifths of the light falling upon it, so that only one-fifth passes through, but two layers allow the passage of

only $\frac{1}{25}$, three layers $\frac{1}{125}$, four layers $\frac{1}{625}$; the above figures then, would represent the actinic effect of the light under the different layers and by no means that represented by the numbers I, 2, 3, 4, 5, as might at first appear, and the higher the figures the greater the difference.

The ratios for Vogel's Photometer are as follows:

Number of layers of paper.	Strength of light.
1	1.27
2	1.61
4	2.59
6	4.17
8	6.70
10	10.84
11	13.86
12	17.38
13	22.11
14	27.88
15	35.45
16	44.89
17	57.01
18	72.51
19	92.08
20	117.50
21	149.22
22	189.17
23	239.7
24	300.7
25	381.9

Consequently, a light that will bring out the figure 25, is about 300 times as strong as the one that brings out the figure 1.[1] It is much the same

[1] If the light whose actinism is 1, becomes reduced to $\frac{1}{n}$ of its power on passing through one layer of paper, the reduction on passage through x paper layers $= \frac{1}{n^x}$ (Lehrbuch, 177).

in Warnerke's sensitometer. The power of light represented by the figures 1, 2, 24, stands here as $1 : \frac{4}{3} : 580$.

It is plain that this circumstance prevents the instrument from being a very accurate one. An error of one figure in the reading off, may occasion a great discrepancy in the result.

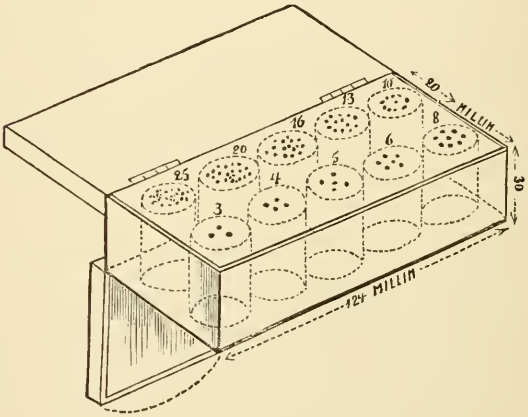
Warnerke's scale also has the disadvantage of being colored with a pigment that favors the action of light. Almost all the pigments hitherto proposed for the purpose, even the black ones, have a yellowish tint, and the consequence is that the quality of the light becomes changed in its passage through so many thick layers.

In all these photometric systems, unequal actinism is caused by forcing the light through many thicknesses of an absorbing medium, thus weakening it.

There is another way of diminishing the power of the light without the employment of any medium (which alters the light owing to unequal color-absorption). This is by the use of stops or diaphragms, well known to photographers for other than photometric purposes. The physicist Done, was the first to use the stop for this purpose (Bericht d. Berlin Akademie, 1861). Taylor afterwards (Phot. Mitth., V. p. 284, 1869) made a pigment-druck photometer on the same principle. It consists of a wooden block having a number of cylindrical canals bored in it and covered over with a leaden sheet in which are a number of openings of just the same size. It is evident that the illumination inside the canals will be in proportion to the number of openings, when the instrument is ex-

posed to the clear sky. The figure represents these openings in the ratio 3 : 4 : 5 : 6 : 8 : 10 : 15, etc. A strip of sensitive paper exposed under these openings will darken more quickly under the higher than under the lower numbers. The author constructed a photometer on this principle twelve years

FIG. 16.



ago for pigment-printing, but rejected it inasmuch as it did not give him the results hoped for. In the first place it had too feeble illumination, and in the second, the great disadvantage of receiving light only from that portion of the sky perpendicularly over it, while the printing-frame, whose action was supposed to be guaged by the photometer, of course received its light from other parts of the sky.

Nevertheless, this instrument[1] has certain advan-

[1] It may be mentioned that this instrument has lately been *rediscovered* by Mucklow and Spurge, who presented it at the meeting of Dec. 13, 1881, of the Phot. Soc. of London, as an "improved

tages, although it is unfitted for pigment-printing; being well adapted for testing the sensitiveness of negative plates; and further, having the illumination (actinism) of the scale represented by figures increasing in arithmetical ratio.[1] Besides this, the light in its passage through the apertures is not altered in quality—a fact that Mucklow and Spurge especially mention.

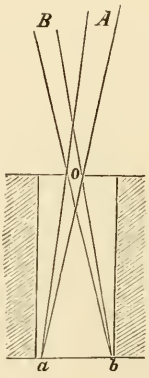
These circumstances led the author to attempt the scale already mentioned for testing dry plates. Many difficulties however stood in the way. When the instrument is exposed to the sky, it is evident that the point *a* receives its light from a different part of the sky from *b*, although there is but the one opening, *o*. If the sky is not equally clear all over (as when clouds are present), it is impossible to obtain even results with this instrument. Other trials proved that the open sky worked by far too powerfully. Even when overcast, a few seconds' exposure

sensitometer." (Photographic Journal, p. 44.) The only difference between Taylor's model and that of Mucklow and Spurge is that the latter placed a single opening only over each canal and increased its size towards the higher figures.

[1] This is a great advantage for photometric purposes—*e. g* , if two plates have been exposed under precisely parallel circumstances, and the figure 3 is obtained from one, while 6 is from the other, these figures will then represent inversely the sensitiveness of the plates. But if openings of different diameters are applied as Mucklow and Spurge have made them, this advantage is lost. For then the diameters of the openings must be made to increase as the square roots of the figures on the scale beneath—*i. e.*, for the figures 1, 2, 3, 4, 5—as 1 : 1,414 : 1,732 : 2 : 2,236, etc. But it is a very difficult matter practically to make openings in just these proportions, while it is a trifling matter to bore any number of the same sized holes with the same tool.

of a wet plate sufficed to bring out the impression of all the figures. Shielding with ground glass proved impracticable, because it did not diffuse the light evenly; and it would be very difficult to get a number of pieces of ground glass for different instruments of absolutely the same opacity.

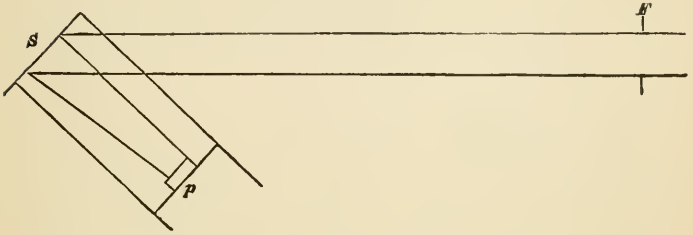
Fig. 17.



Therefore, the author attempted the preparation of an evenly illuminated surface, and he succeeded by covering a reflecting screen with plain photographic paper. The latter is the whitest substance obtainable, being prepared with the greatest care and out of the choicest materials. No other substance can be had of such uniform quality, and no other, except snow, reflects white light so perfectly; furthermore, it is always easy to be had. If such a screen (*S*, Fig. 18) be placed opposite a window, *F*, opening to the clear sky, and at the proper distance from it, all points of the screen may be considered

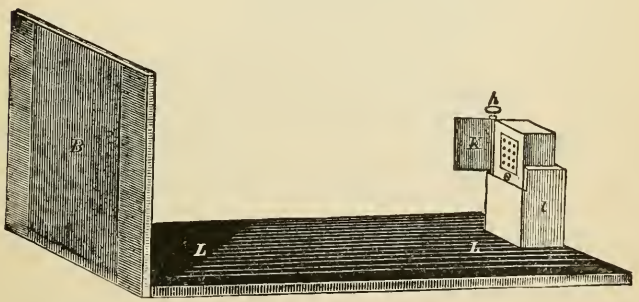
as equally illuminated,[1] inasmuch as the angles at which the light strikes different points of the screen are nearly the same when the window is small

Fig. 18.



enough and at the right distance. So that the single points *a* and *b* (Fig. 17) of a plate exposed in the photometer are exposed to light of the same strength, particularly if the canals are cut long enough, so that the size of the opening, *o*, as seen from *a* and *b*,

Fig. 19.



is the same. The actinic effect of the screen upon the photometer will directly depend upon the dis-

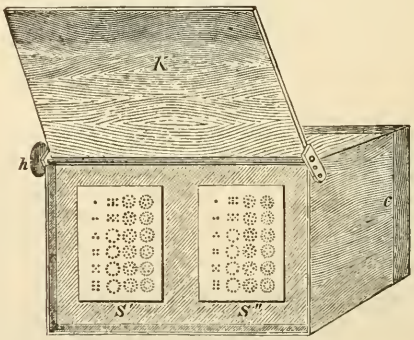
[1] See Vogel, Principien d. Beleuchtung u. Atelierconstruction diese Zeitschrift, V. Jahrg., 70. Also, Lehrbuch, p. 225.

tance between them. The author consequently arranged a horizontal board (*L*, Fig. 19) so as to bring the two within a fixed distance. The board was furnished with a cross-piece, *B*, at one end, 16 inches square; the other end carrying a block, *l*, for the photometer, so arranged that the scale of the latter is exactly one metre distant from the screen (39.37 inches).

The cross-piece is covered on the side next the photometer with a sheet of ten-kilo photographic paper. The sheet is neatly cut, dampened, and glued on the edges, and then laid smoothly on the board. When dry, it presents a perfectly even surface.

The arrangement of the photometer is perfectly simple. It has a flap (*K*, Fig. 20), worked by the

Fig. 20.



handle *h*, for exposing. The back part is made like a plate-holder. The cylindrical canals at the back part are covered with a copper plate in which figures are cut giving the number of holes above them.

The manipulations are easily understood. The

two plates to be compared are exposed quickly, one after the other, to the same light; they are developed together in the same bath, and the lowest figure appearing on both plates is noted. But it is presupposed that the light remains even during the exposure; this is one advantage of working by artificial light. Daylight is very variable; even when the sky is perfectly clear, the height of the sun causes differences, and when cloudy, still greater ones arise. In order therefore, to make perfectly fair comparative trials between plates, they must be exposed together. The author therefore, arranged the photometer double, giving it two scales of precisely the same density. There are 24 canals, arranged in 4 rows of 6 each. The openings over the canals have a diameter of about $\frac{1}{40}$ inch, their number increasing *pari passu* with the canals from 1 to 24. The scale is 4 inches distant from the sensitive plate, and the back of the apparatus is so arranged that two $3\frac{1}{4}$ by $4\frac{1}{4}$ inch plates can be exposed side by side.

As both sides of the double instrument are opened and closed simultaneously by the flap, any error, such as might easily occur if the plates were exposed one after the other, is effectually avoided.

But the instrument is not alone useful as a photometer for the negative process (sensitometer so called), but also as a measurer of actinism. For this purpose a stock of plates of the same sensitiveness is required; single plates are then exposed at different times and developed in the same manner. The figures obtained will represent the actinism inversely. It will not always be possible to prepare plates of

absolutely the same sensitiveness, but if a stock is on hand prepared from the *same emulsion*, they may be regarded so. If another batch of plates is to be used for actinic measurements, they should be carefully compared with the first batch, in the manner already described, and the difference noted and allowed for.

It may be objected that Roscoe's improved form of Bunsen's photometer (with chloride of silver on paper, Lehrbuch, 125) is sufficient for testing the actinism of daylight. This is not the case; the paper being so feebly sensitive that when the sun is below an elevation of 12°, the direct chemical effect of its light cannot be registered; while every photographer knows that instantaneous pictures of the sun's disk may be taken at its setting. Therefore the necessity for a more sensitive photometer.

It need scarcely be said that the actinism of different lights — such as daylight, gas, the electric light, etc.—may be compared by means of the former instrument. Two of them may even be compared when having openings of different sizes. If the diameter of the openings in one of them be represented by o, and in the other by O, then the ratio of illumination in the two instruments will be as $o^2 : O^2$. Again, if the distance of the plates from the openings of the scale is e in the one, and E in the other, then the illuminations will be as $\frac{1}{e^2} : \frac{1}{E^2}$. The formula $\frac{o^2}{e^2} : \frac{O^2}{E^2}$ will then give the relative intensities of light of the two instruments.

This advantage, that two different instruments of

the same kind may be very easily compared by means of calculation, is offered by no other form of actinometer. It is plain also, that the instrument is capable of being used in many different ways. If the strength of light in the studio is required, the instrument may be used with the screen (Fig. 19); likewise when the actinism of any special part of the firmament is to be decided. The screen will also be necessary when comparative trials are made between daylight, electric light, and gas.

The actinism of a given part of the clear sky (free from clouds) can also be determined by the aid of this instrument.[1] For example, let it first be laid horizontally so that the canals are directed perpendicularly upwards. After exposure, let it be turned so that they are directed towards the horizon, and a second exposure made.

For comparative trials of sensitiveness, let the screen be so placed that it receives illumination from a small window, about 4 feet square, at about 20 feet distance (the window should open to the clear sky, and if possible be on an upper floor). Put the closed instrument in its place (see Fig. 19), and open the flap, holding a watch in the hand; 1 to 12 seconds may be given, according to the light; the development is then proceeded to with all precautions given above. After about 4 minutes' action of

[1] The opening being taken with the above dimensions, it will be easy to determine the space of sky, $a\ o\ b$, which has chemical action. The distance of o from $a\ b$ is 4 inches, and the size of $a\ b$ itself rarely over $\frac{3}{4}$ inch. The angle $a\ o\ b$ is calculated from the tangent of the half-angle, $\frac{a\ b}{2.100} = \frac{1}{20} = 2°\ 50' \therefore a\ o\ b = 5°\ 40'$.

the developer, the plate is quickly washed with water, but *not fixed*, the figures of the scale appearing much more distinctly on the unfixed film. A convenient method of closely examining such results is to surround a lamp with an opaque shade of tinfoil, with an opening the size of the plate cut in it, so that no direct light from the lamp reaches the eye, but all is concentrated on the plate when laid over the opening.

The higher numbers (24, 23, 22, etc.) will come out first. Then the lowest one developed must be sought for; this is not easy, and requires some little practice.

If, for example, one plate shows 7 as the lowest visible number, and another plate 14, it follows that the light under the number 7 (in the first plate) has produced the same effect in the same time as the light under 14 in the second plate. Now, since twice the light is required in the second case to produce the same effect, it follows that the latter plate is only half as sensitive as the former.

Three plates were exposed between twelve and one o'clock, Jan. 20th, the weather being quite settled. No. 1 received 3 seconds; No. 2, 6 seconds; and No. 3, 9 seconds. The result was that on No. 3 the figure (of the scale) 2 was obtained; on No. 2, 4; and on No. 3, 6. From this the law may be laid down that, *under parallel conditions, the figures obtained stand inversely to the length of exposure. An indispensable requisite is that the plates to be compared shall develop perfectly clean. Any small defect occupying the position of the lowest figure renders the plate worthless.*

Sometimes a single trial will not give a reliable

result. If two plates are exposed, of which one is twice as sensitive as the other, and the figure 7 is obtained on the least sensitive one, the other ought to give the figure $3\frac{1}{2}$. But this is not contained in the scale of the instrument, 4 being the nearest figure. The sensitiveness would then appear as $4 : 7 = 1 : 1\frac{3}{4}$, instead of $1 : 2$. For the sake of certainty the trial should be repeated, and an exposure given not more than half so long, so that if 17 is obtained with one plate, the other may give 9. Then the sensitiveness would appear as $1 : 1\frac{8}{9}$, which is considerably nearer $1 : 2$.

Thus the accuracy of the instrument is greater the higher the figures obtained, and it will be well to give as short exposures as possible.

This form of photometer will be chiefly employed as an instrument for comparisons — *i. e.*, for the determination of the relative sensitiveness of prepared plates which are exposed in it simultaneously and developed in the same bath. Here no attention need be paid to the *temperature of the developer*. But it is very different when actinisms are to be measured at various times, and the plates used developed in different baths; the results being directly affected by the temperature of the developer. The author gave two plates from the same emulsion equal exposures side by side; one developed at 54° F. gave 12, while the other developed at 72° F. gave 8 (the developer being the same in composition), so that the one plate was apparently to the other as $8 : 12 = 2 : 3$. Therefore results from the same plates obtained at different times may only be compared

when developers of the same composition and the same temperature are used.

These comparisons of results at different times will be less useful in photographic practice than in scientific investigations. For the latter, the temperature 66° F. for the developer may be recommended—ice in summer, and warm water in winter, easily producing it.

Concerning a Unit of Light for the Photometer.—Vogel's photometer affords a means of determining the comparative sensitiveness of plates or of the actinism prevailing at different times. It is important then, to be able to refer these different ratios to a fixed unit, and this may best be done with magnesium. The instrument (as in Fig. 20) is set up in a dark-room, and 1 gramme (15.43 grains) of magnesium wire ignited immediately over it, so that the distance from the screen is just a metre (page 136). The photometer is previously covered with a lead plate to prevent its being injured by the falling hot scoriæ. The sensitive plates are then developed for 4 minutes at 66° F., if possible. Assuming that the magnesium light has thus brought out the figure 18, this may be taken as the unit for 1 gramme of magnesium. If the same plates are exposed to daylight for 10 seconds, and the same developer gives the figure 12, then the daylight at that hour works $1\frac{1}{2}$ times as powerfully as 1 gramme of magnesium. Thus it may be assumed that the actinism (in ten seconds) equals $1\frac{1}{2}$ grammes of magnesium. In this manner all determinations may be referred to magnesium as the unit, without the necessity of burning the wire every time that a test is made.

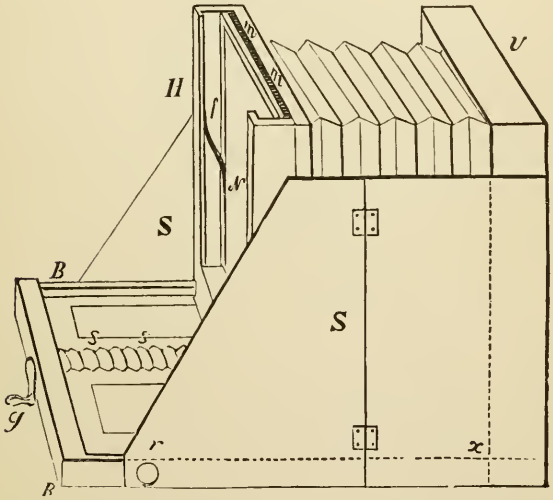
CHAPTER V.

PHOTOGRAPHIC APPARATUS.

A.—CAMERAS, CHANGING-BOXES, AND TRIPODS.

Landscape Apparatus.—The advances made by the dry process of latter times, have given a fresh impetus to landscape photography, and explain the great increase in the number of amateur photographers who especially follow this department of the art. The corresponding increase in the demand

FIG. 21.

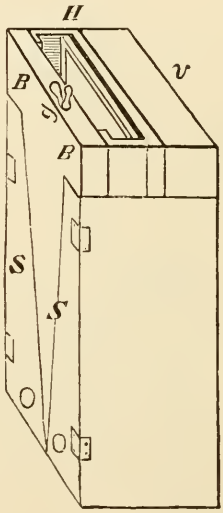


for apparatus has led to the construction of the portable varieties for travelling, as well as instanta-

neous shutters, tripods, etc. We will describe the principal forms.

In North Germany, the form of camera described in the Lehrbuch, 3d ed., p. 273, and shown in the accompanying cut (Fig. 21), opened for use, and closed for travelling in Fig. 22, is still the favorite

Fig. 22.



one. When dry plates are to be used, we may either work with the double holder (Fig. 23), or the changing-box (see p. 150), the latter allowing a much larger number of plates to be carried, and to be changed in broad daylight, but it has this disadvantage, that the plates must be of absolutely the same size and thickness.

The author's favorite apparatus is furnished with three double holders, holding six plates, and for

long excursions he carries with him extra plates in packages of half a dozen.[1] The plates may be changed every evening by means of a lamp covered with a red chimney. Six plates will generally be enough for the day's work. The advantage of the double holders is that different sized plates may be used by having suitable inner frames to fit them, while the changing-box admits one size only. Further, plates that have been carelessly cut, or made on uneven glass, can be more easily used in the holders than in the box.

Jonte's Landscape Apparatus.—Jonte had an interesting series of apparatus at Vienna in 1880, which was specially recommended by Pizzighelli,[2] and received the prize from the French Ministry of Public Instruction on the occasion of the competition instituted by the *Société Francaise de Photographie*, for "Photographic Apparatus for Scientific Expeditions to Foreign Lands."

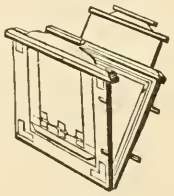
Jonte's camera when closed forms a rectangular body of very small size (the camera for plates $7\frac{1}{2} \times 9\frac{1}{2}$, measuring $9\frac{1}{4}$ inches in length, $9\frac{1}{4}$ inches in breadth, and 4 inches in thickness); when desired to be set up, it is set on the head of the tripod closed, and so that the ring of zinc screwed on the bottom comes

[1] The apparatus used by the author was made by Stegemann 151 Oranienstrasse, Berlin, and is quite equal to the celebrated English work. Instead of the screw *S S*, Stegemann uses a rack and pinion for focussing; and instead of two side-boards *S S*, the smaller cameras have only one. The most useful size is that for plates 5 x 8 inches, and we recommend it particularly to amateurs and travellers.

[2] Introduction to Photography for Amateurs. by Pizzighelli, Vienna. Published by the Phot. Correspondenz.

against the corresponding ring on the tripod-head; it is then screwed fast by the screw-bolt. The buttons on the long sides are then pressed, so that the springs connected with them are loosened. The back part of the camera is then applied to a pin on

Fig. 23.



the base-board and secured in position by a simple twist. This arrangement which is a very ingenious one, admits of the camera-body being set on vertically as well as horizontally; the change from either position to the other being very quickly done with almost a single movement of the hand, all extra screws and other appliances for reversing being dispensed with.

The arrangement of the front panel carrying the lens is just as simple; this latter remaining stationary, while the body can revolve on a horizontal axis. Two zinc rings are employed for this purpose, of which the outer one is connected with the drawing-out part of the camera, while the inner one is screwed to the lens-panel.

The front part of the camera is drawn out from the back part, a brass plate is let down, and the lens-board fixed at any desired angle by means of two screws, while corresponding female screws allow it to be moved up and down; the sideway movement

being done with the hand. The apparatus may be used either with lenses of very short or very long focus. When the double bellows is entirely drawn out the lens is 22 inches distant from the ground-glass; the shortest distance, when the camera is closed, being $3\frac{1}{4}$ inches.

The sliding part of the base-board consists of two movable wooden frames controlled by a long screw-spindle and winch. When the innermost frame has gone as far forward as possible by turning the screw, its back end engages with a projection on the second frame and carries the latter with it. After a few turns, the second frame has gone so far that the female screw in its back end is caught on the spindle and governed by it from that point forward. (The back part of the long screw-spindle has no thread, and is of smaller diameter, so that, when the apparatus is closed, the female screw of the back frame is beyond the thread of the spindle, and only engages with it when pushed forward by the inner frame as described.) At the same time a spring is let loose, preventing the first frame from being drawn back by the resistance of the camera-bellows while the second frame is being moved forwards.

The ground-glass is furnished with hinges, allowing it to be laid over sideways or up out of the way, as the case may be. While focussing, or when the camera is closed, it is secured in its regular position by means of a spring catch.

Five double holders, remarkable for lightness and strength, are supplied with each camera. They are made of light wooden frames, separated by a septum

of heavy blackened cardboard into two equal halves. Each of these halves holds one dry plate, so that in all, ten exposures can be made without change of plates. The sliding door of the holder can be folded around to the back and there secured by small hooks on the base-board, if the wind is blowing. When the doors are in place they are held there by small spring catches, so that an accidental opening during transportation is impossible. On the outside of each holder, at the right hand, a small disk of parchment is let into the wood to serve for noting down the exposure, etc. On the left side is a small slide with figures corresponding to the number of the plate; this is pushed to the left when the plate is exposed, thus bringing into view the word *posé* (exposed); every exposed plate therefore, is registered, and errors arising from the double exposure of one plate effectually avoided.

A movable covering hung over the lens protects it from false reflections of light. All the sliding parts of the camera run in brass grooves, wood being entirely avoided for this purpose. Marine glue is used for the whole. Irregularities, such as are caused by swelling in damp climates, can therefore never occur. The camera is made of pear-tree wood. The tripod standing ready for use, has a star-shaped head on which a zinc ring is screwed, as mentioned above. The central screw, as well as the bolts for fastening the feet, are secured permanently to the apparatus, and consequently cannot be lost. The legs may be pushed together, being held when open by two brass rings, and are permanently fastened at the foot. When set up, the lower parts are pushed out,

and fixed immovably by turning a lever. If it is desired to shorten the total height, it is only necessary to loosen the levers of each leg, push the sliding legs into the proper place, and refasten the levers. The legs are fastened to the head by means of circular slots at their upper ends, which fit on screws on the tripod-head, and a small cap afterwards screwed on ensures safety and rigidity.

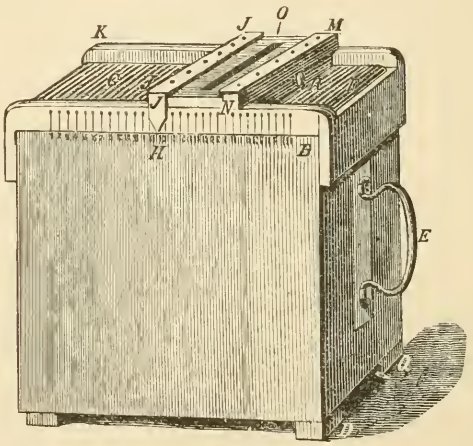
The camera and holders, together with the folded tripod, are kept in neat cases of enamelled leather.

The tripod can either be buckled to the camera case, or carried by itself by the handle on its own case; and the camera may either be slung over one shoulder or carried knapsack-fashion by properly arranging the straps. The weight of the apparatus when packed is $20\frac{9}{10}$ pounds.

The Changing-Box, of whose advantages and disadvantages we have already spoken, plays an important part in modern landscape photography with dry plates. Its chief recommendation is that a large number of plates with *only one holder* may be carried, and the changing effected in open daylight. But it is an indispensable condition to have plates that fit exactly, and to see that they are all of the same size. The changing-box consists of a box, *K B D Q* (Fig. 24), furnished with feet, *C D Q*, so as to stand steadily on stony or uneven ground. It is carried by the handle, *E*, and contains 24 plates. The grooves inside are well rounded, so that the plates touch by the extreme edges only, and the sensitive film preserved from injury. The floor of the box is lined with gutta-percha. *G F* is a *jalousie* shutter or slide, which moves in the rabbet grooves,

K M H B, easily, and yet allows no light to pass. The part *J J M N* consists of a small board, *M N*, fastened to the cover, *G J F*, and moves with it in the grooves. This board has an opening, *O*, the width of the plate, which is kept closed by a strip on the inside connected with a strong spring. But when the knob, *R*, is pulled out, the strip (which is

Fig. 24.

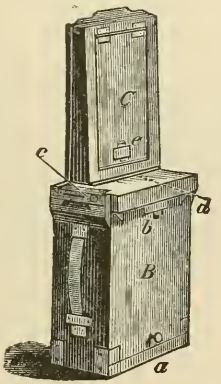


fastened to it) follows and opens the slit, *O*, which, of course, may be closed again by releasing the knob. *H B* is a strip of brass bored full of holes, standing at exactly the same distance from each other as the plates in the box. *H* is a pointer with a hole corresponding exactly to the holes in the brass strip, over which the entire cover and pointer are made to slip. Under the holes are numbers from 1 to 24. If the pointer, *H*, be brought opposite to a given hole and fastened here by means of a pin secured to

the box by a string, the plate corresponding to the number where the pointer is fastened will pass through the slit, *O*, after the strip on the inside (which is worked by the knob, *R*) is drawn back. In the same manner, exposed plates may be returned to the box. Afterwards, the pointer, and with it the whole top part, *G F*, may be slipped on to another number. Thus a glance will tell how many plates have been exposed, and how many still remain to be.

In order to change plates in daylight without injury to the sensitive film, the holder, *C*, is made use of (Fig. 25). This holder has no back door for

Fig. 25.

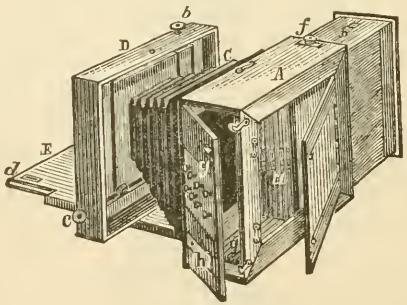


putting in and taking out the plate like the ordinary form, but a slit-like opening at *d*, with a brass plate carefully fitted so as to slip light-tight in the corresponding grooves, *J J N M* (Fig. 24), and thus form temporarily a part of the box (Fig. 25). When this has been done, the pointer, *H* (Fig. 24), is moved to the number of the desired plate, the bolt of the

spring door, *C*, let loose, *R* also let back (Fig. 24), and the whole affair turned upside down. The plate slides into the holder, and, after closing *R* and *C e*, the holder may be removed from the box.[1] The return of an exposed plate to the box is done in the same way. The floor of the box, *a* (Fig. 25), can be opened for putting in and taking out the plates. It is guarded with a lock and key.

Enjalbert's Travelling Camera and Changing Apparatus.—Enjalbert, in Paris, has constructed a form of apparatus in which camera and changing-box are combined. It is thus arranged: the camera carries a broad box behind, *A* (Fig. 26), in which the

Fig. 26.



changing-box, *B*, may be slipped in and out. This latter contains a number of thin wooden frames in which the dry plates are securely fastened. The side edges of these frames are provided with screw-holes, *a*, with corresponding screws, *g*, in a door, *h*. If the door, *h*, be closed and the box, *B*, pushed in,

[1] Fig. 24 shows a large box (to hold 24 plates); Fig. 25 a smaller one.

these screws will enter their respective holes at *a*, if turned. Therefore, if one of the screws be turned, and the box, *B*, pulled out, that frame with dry plate operated on by the screw will be held back, and the plate will be in the proper position for exposure. In order to focus, the whole box, *K*, is withdrawn, and the ground-glass introduced in a groove corresponding to the plate to be used, being afterwards withdrawn in the ordinary way.

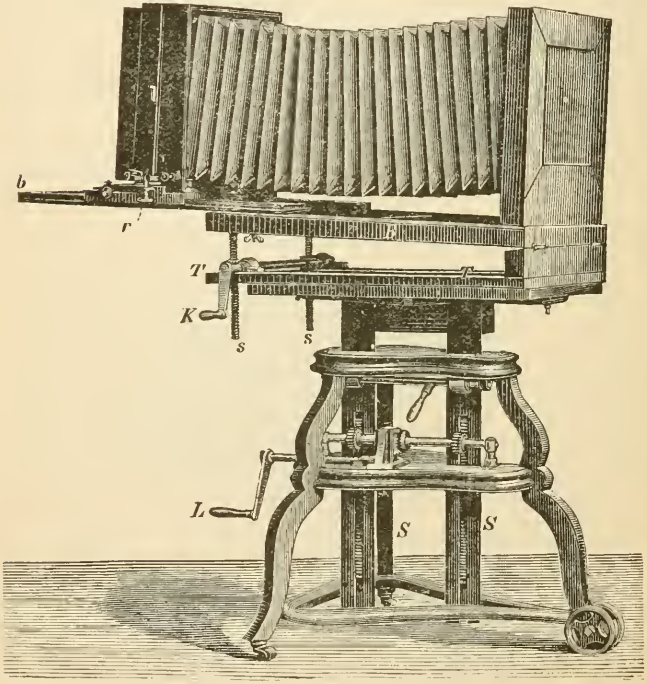
The apparatus in fact, admits of the change being easily made, and weighs decidedly less than a set of double holders or a changing-box with holder. Crooked or irregular plates are also more easily worked in Enjalbert's apparatus than in the changing-box. The conception is an ingenious one.

The camera itself has some little improvements, such as screws, *b* and *c*, for the vertical and sideway movements of the lens-panel: a base-board with holes for adjusting short and long foci; rack and pinion for focussing, etc. The camera is not secured to the base-board by screws, but by buttons somewhat like the well-known bayonet fastening, and very practical. An apparatus for half plates ($5\frac{1}{4}$ by $7\frac{1}{4}$ inches) weighs only $4\frac{1}{4}$ pounds.

New Apparatus for the Studio..—Here we may mention the form constructed by Gareis after Schaarwächter's model (Fig. 27). This camera rests on a sort of table, *T T*, and may be moved in one direction by its own front board furnished with hinges, and in the other by the screws, *s*, *s*. By means of the latter, the camera may be either placed horizontally or inclined forwards or backwards. The screws are worked by the winch, *K*, and the table, *T*, can

revolve on an axis (not seen in the figure), so that the camera can make rotary movements without the necessity of disturbing the stand. The arrangement of the tripod may be seen from the figure. The base-board, *B*, of the camera has an extension work-

Fig. 27.



ing in grooves by which its length may be nearly doubled. This extension carries the ground-glass, which can be moved both horizontally and vertically by screws not seen in the figure. The focussing

arrangements are the same as those described on page 272, Vogel's Lehrbuch. The camera offers the advantages of having all the movable screw-heads within easy reach from the back, and of giving great length of draw with but little trouble.

New German Tripods.—The Alpenestock tripod (Fig. 28), when folded up, forms a rather thick stick,

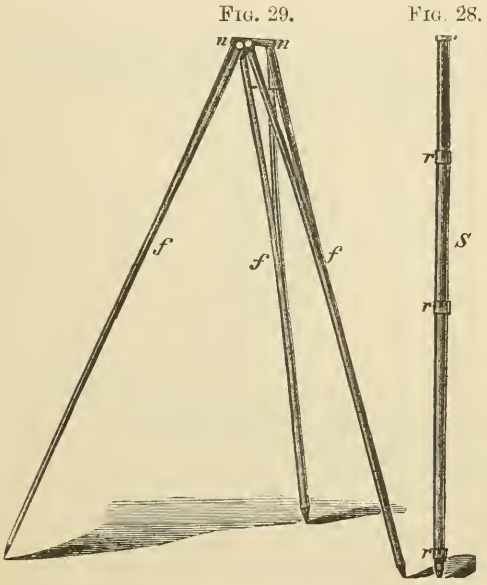
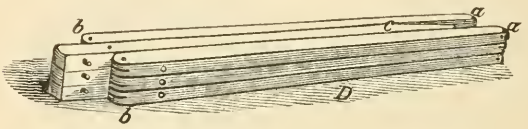


Fig. 29. Fig. 28.

5½ feet long. As it name implies, it may be used in mountain-climbing. It is formed of three pieces held together by rings, *r r r*. As seen in the figure (Fig. 29), each piece or leg has two pieces at the top fitting into the metallic triangle *n n*, which serves as support for the camera.

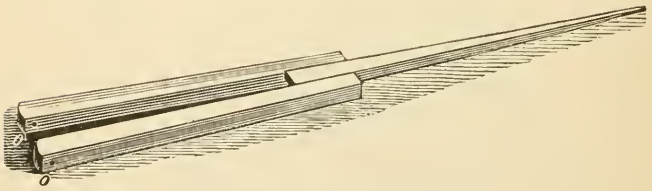
This tripod is remarkably steady in spite of its light weight. Its only drawback is that it cannot be easily packed on account of its length. On this account, we prefer the folding form of tripod as made by Stegemann and Martini (of the firm of Schippang). The three legs form a bundle when

Fig. 30.



packed (*D*, Fig. 30). At *b b* are hinges allowing the parts *a b* to be turned—thus opening the tripod, as shown in Fig. 31. At *o* are holes corresponding to

Fig. 31.



pegs in the metallic triangle-head, which, as before, forms the support for the camera.

Wonderful improvements have been made in cameras both for landscape work and the necessities of the studio, in America, during the last few years.

This has been largely brought about by the very rapid growth of amateur talent in that great country. Not only are improvements made in the direc-

tion of large cameras, but those of the tiniest proportions are made for artists, detectives, tourists, etc.

Fig. 32.

Figure 32 represents one of these last-named cameras closed up.

Fig. 33.

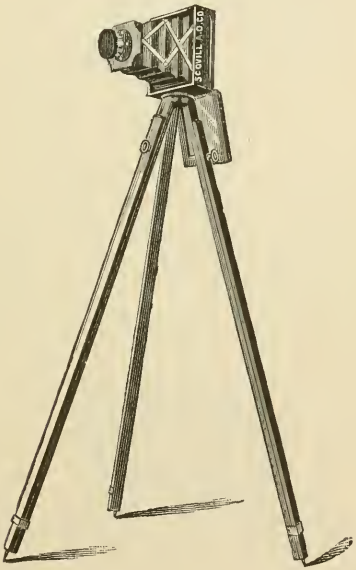


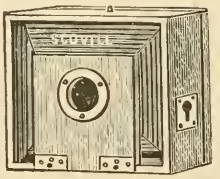
Figure 33 represents the same piece of apparatus attached to the tripod and ready for work.

It is exceedingly light as well as small, and is

intended to be used with as little ostentation or show as possible, that the object of the artist may not be defeated by the appearance of his apparatus. A rapid lens is supplied with the camera, duplicate plate-holders, and the pneumatic exposer. By means of these, pictures may be secured with rapidity and ease, while no one else in the world but the "man at the helm" would suspect anything of the kind going on.

While, as a rule, it can hardly be recommended to any one desiring anything like satisfactory results to employ a camera smaller than 5 by 8 inches, yet there are those who move about in different parts of the world who desire to secure some pictorial representation of their progress, who find a smaller size convenient for their use. Tourists' pocket outfits have been devised for such persons, of very neat design and convenient form. These are made to work for either horizontal or vertical plates. Such a camera, folded for carrying, is represented in Figure 34; and the same camera, packed for car-

FIG. 34.

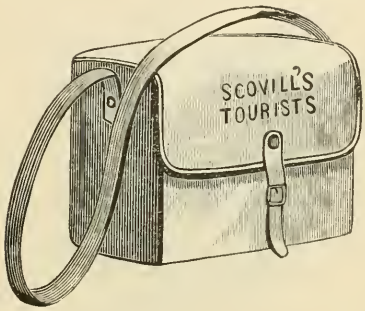


riage, will be understood by referring to Figure 35.

The 4 by 5 size measures, when folded up, $5\frac{3}{4}$ by $6\frac{1}{4}$ by 2 inches only, and is freed from any projecting parts, so that it may be slipped into the pocket

very readily. Rods are supplied upon which to move forward the front of the camera, and these may be easily detached and drawn out of the bed. Just as readily the connector at the other end of the

Fig. 35.

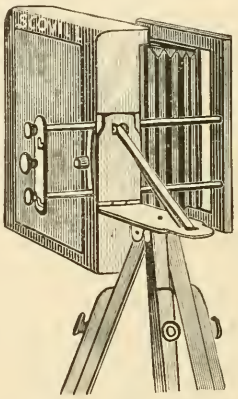


camera is displaced, and only a moment of time is required to replace them all.

The weight of this camera, with its holder, is only $1\frac{1}{2}$ pounds. It is considered a great improvement to have the improved bellows arranged, as shown in the cut, forward of the body of the camera, and not in it, as is customary; for in this way the centre of gravity is located where there will be less of vibration when in use. Moreover, the focussing cloth is never disarranged. Once the focus is adjusted, further movement of the lens is checked by means of the screw acting on a spring which is pressed at the ends against the focussing rods. It is a very convenient apparatus indeed. The method adopted for reversing the camera so as to enable the operator to make either a vertical or horizontal

picture is shown in Figure 36. A brass plate is fastened at the bottom of the camera; a similar plate is hinged to it so that they open in the form of a right angle, and thus hold rigidly in position—or they may be brought together and tightly clamped

Fig. 36.

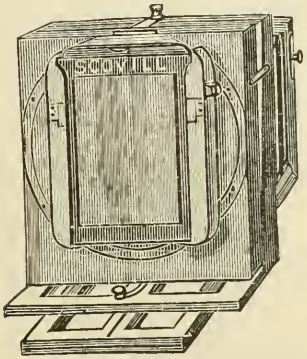


by a rod with a hooked end which is placed in the opening of the brass plate, secured to the tripod top, as will be seen by the drawing. The camera is set or unset at pleasure upon the upper plate, and, whether in a vertical or horizontal position, is held very firmly so as to be secure against vibration. The reversal can be effected in an instant, and there is no danger of an over-turn.

A very ingenious method of reversing the plate-holder has recently been patented by Mr. Flamming. The carriage revolves, and, when in the place desired, is automatically fastened. This is a great improvement, and will be appreciated by out-door

workers. Very often one is in doubt as to how a view should be taken—vertically or horizontally; and the old method of reversing the camera made it a real job to try both ways in order to decide.

Fig. 37.



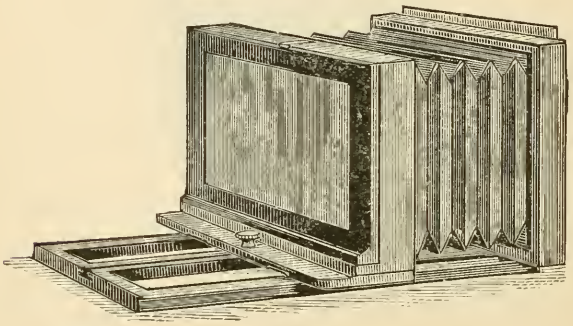
This need be no longer the case, for, as plainly shown in the drawing, the trial can be soon made. The revolving-back camera is sure to be adopted. The trade is largely indebted to Scovill Manufacturing Co., Proprietors of the American Optical Co.'s Works, N. Y., for encouraging so many improvements in cameras and producing them for the public good.

In portrait cameras there are a number of improvements which are worthy of mention: The reduction of price at the expense of quality can hardly be considered an improvement, but when the price can be reduced and the quality retained, it should be mentioned. Therefore, a grade of cameras has been introduced into the market at a low price,

and which are at the same time good, well made, true, and reliable, to meet a want that has often been expressed by beginners. It is always good to meet such wants, upon the same principle that a desire for cheap articles should be encouraged for the reason that it always leads to a wish for better.

Figure 38 represents one of these cameras, which are made of various sizes, from a quarter size to 8 by

FIG. 38.



10 inches, both with reversible holders and without. In the better quality of camera-boxes, one of the latest improvements is in the arrangement for supporting the holder between the time of arranging the figure and the exposure.

The improvement is applied to what is known as the "Imperial" camera for making more than one picture on a plate. It will be seen by reference to Figure 39 that there is a carriage supplied for the plate-holder, and by this arrangement the ground-glass is always ready in place for use. When the plate-holder is brought from the dark-

room it is slid into the carriage, instead of placing it on the floor, or in some other inconvenient

Fig. 39.

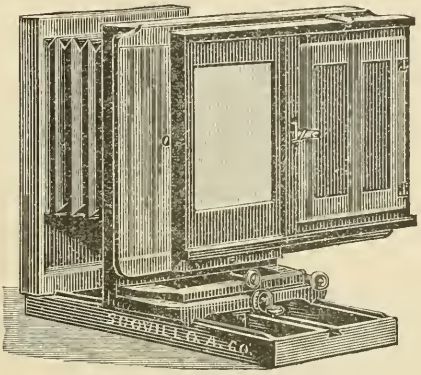
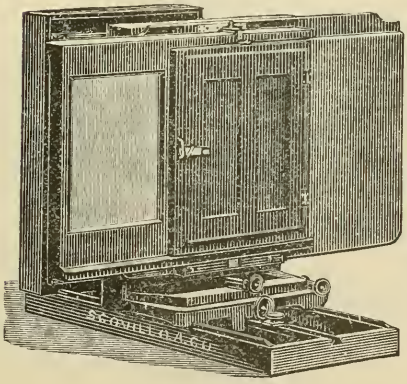


Fig. 39a.



place, while the focus is obtained. After securing the desired pose, the ground-glass is pushed

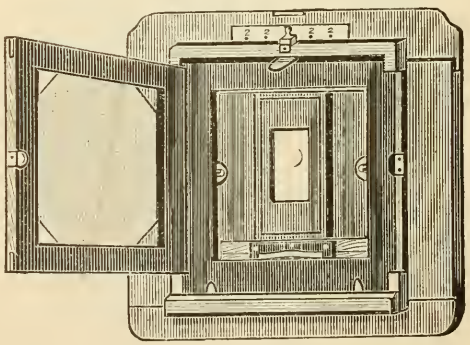
to one side instead of removing it, and simultaneously the plate-holder is brought into place. (See Fig. 39A.)

This camera is known in the market as the "Royal" camera.

One great point about all of these American cameras is the excellent quality of their manufacture. The best material in every respect is used without stint, both as to metal and wood-work, as well as the bellows, and they are finished in the highest style of the manufacturer's art. Most of the boxes made for more than one picture upon a plate are known as the Imperial boxes, and some of them have their carriage arrangement for the plate so constructed as to move right and left, up and down. Figures are supplied upon a brass plate at the top of the carriage to guide the operator in his movements.

Figure 40 makes this arrangement quite plain and

FIG. 40.

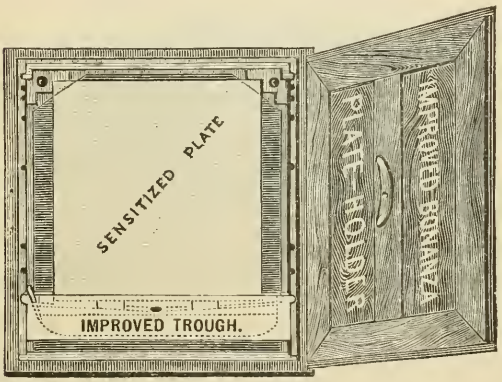


understandable. Certainly a great advantage is supplied here over the old style.

Another great improvement, adopted more largely by Americans than any other people, is for the saving of the silver waste. How much better it is to economically save the drippings from the plate-holder than to permit them to splatter over the floor of the dark-room and studio, and even upon the clothes of the operator and his patron, as is often the case. Therefore, the American cameras are supplied in these days with what is known as the "Bonanza" plate-holder.

This silver saver is illustrated by Figure 41. The

FIG. 41.



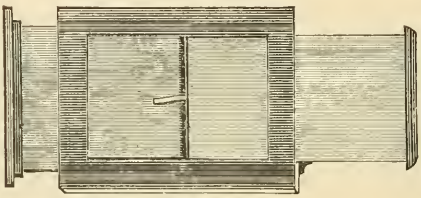
practical photographer can see at a glance at the illustration where the great merit of this holder lies, and how completely a silver solution is saved. The trough may be fitted in the different grooves, avoiding the necessity of what are known as "kits."

It becomes necessary in ordering such a holder as this that the old holder should be sent as a sample, so various are the forms and sizes of camera-boxes,

or else the exact dimensions of the old holder should be given. It is believed that the price of the Bonanza holder is soon saved in the amount of waste it prevents.

The demand on the part of amateurs for "lightness," and the introduction of dry plates, has necessitated special holders, which should not only be lighter than the old holders, but protected more closely against the admission of light. A number have been introduced. One of these, represented by Figure 42, is known as "The New Style Holder."

Fig. 42.

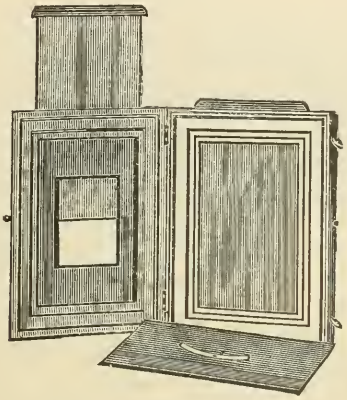


It is constructed so as to carry two plates of equal size, but without kits, and is reversible. It is not adapted to plates larger than about 14 by 17 size, on account of the great weight of two such large plates of glass, taken in connection with that of the holder, making it cumbrous and hard to handle.

The old style of holder is represented by Figure 43, and opens, as will be seen, like the covers of a book when the plates are to be put in. These are so devised that kits of lesser sizes can be carried in the outside frame, which permit of plates of different sizes being used in such a holder.

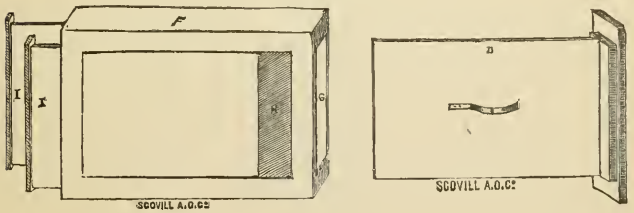
Another pattern still is known as Scovill's patent (Fig. 44). This is also reversible, and made to carry two plates, but no kits.

Fig. 43.



These last have some advantages over the new-style holder, but, as they are a great deal more trouble to "load" and "unload," they are not so

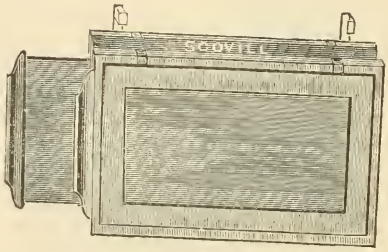
Fig. 44.



much used, except, as in the former case, by those who desire to make various sizes with one camera.

A third kind of holder, represented by Figure 45, is known as the "Daisy" Dry-Plate Holder. It has the great merit of being lighter and occupying less

FIG. 45.



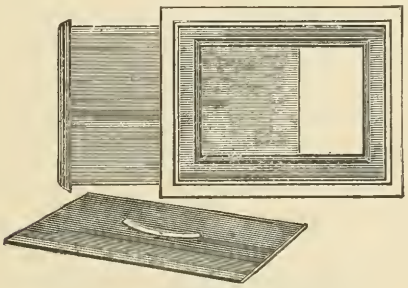
space than any other substantial holder, and, although constructed to hold two plates, is no thicker than a single holder. It also opens like a box when the dry plates are put into it or taken out of it, and it is so arranged that light cannot penetrate from one side to the other. There are no projecting screws on this holder, the dry plates being held by a very simple and effective arrangement. The slides have no catches, as they are unnecessary.

Last of all, I have to refer to the "Flammang" dry-plate holder, which is so arranged that plates of different sizes can be placed in it. This holder is especially adapted for use with landscape cameras, because it is so very compact. It is also for use with large-size plates in the studio. Its construction is so unique that no intermeddling person can withdraw the slide and expose the plate to the action of the light. This is a great advantage, because many who have used other kinds of holders have suffered

from the meddlesome hands of persons curious to see what was within the mysterious little cases.

Figure 46 makes this so plain that further descrip-

FIG. 46.



tion is unnecessary. All of these things are matters of progress well worthy of mention. The extensive adoption of the dry plate has also made various other contrivances necessary. Always on the alert, the manufacturers and dealers have supplied the wants. One of these is represented by Figure 47, and is

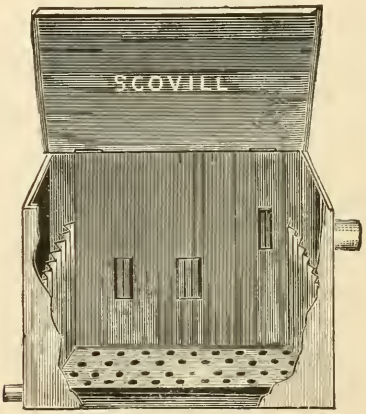
FIG. 47.

known as the Scovill Oxalate Bottle. It is used for holding the stock solution of the oxalate developer,

and for convenience in measuring out the solution for the development of the plate.

The very thorough washing required by dry plates has made it a source of no little trouble among photographers to know how to secure this thorough washing. The manufacturer again comes to the rescue. It is impossible to watch the plate during the whole time of its washing, and it is unnecessary, provided a flow over it is continued gently. A negative washing-box has therefore been employed for this purpose, represented by Figure 48. The plates

FIG. 48.



are simply slid into the grooves so that the film cannot be disturbed. A bit of hose is slipped over the tap, the other end over the spout on the box, the water is turned on, and the operation begins. A false bottom is also supplied with perforations to every square inch, and the receiving pipe conducts

the water underneath the false bottom. The result accomplished by this form and construction is to prevent the water passing through the box with too great force. Not only is it checked, but it is equally distributed, so that every plate, and each portion of the plate, is washed equally. Moreover, the adaptability of the box, as it is called, is improved by grooves being supplied for various sizes of plates. The simple means are made plain in the drawing.

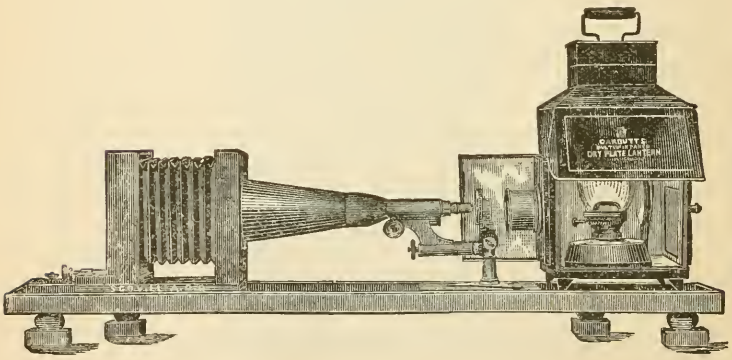
Amateur photography has brought one more desirable piece of apparatus into the market which should not be overlooked. I allude to one devised for the making of photomicrographs with the microscope. This beautiful department of our art has been worked at by few, and heretofore it was only accomplished by the aid of elaborate and costly apparatus. It was then applied chiefly to the purpose of making illustrations for scientific magazines, or for physical examination. Now, however, with the recent improvements in photography, and the introduction of gelatine plates, the photographing of microscopic objects becomes of as easy accomplishment as does the photographing of the visible objects of nature with the popular amateur outfits. Instead of spending hours in making a draught by hand, a man, aided by the camera, will illustrate a scientific subject with a few microscopic objects made in a short time with the assistance of photography, which can produce a more perfect representation of the minute object than it is possible for one with the hand to do working jointly with the eye. Not only can an enlarged image of the microscopic object be formed for illustration, but pro-

fessors in colleges will find it a ready means of producing negatives of suitable size from which can be made transparencies or magic-lantern slides for public exhibitions.

If this is done in the daytime, a room from which all white light is excluded should be selected; but if it is used at night, as it is in most cases, it would be an operation that could all be performed in the midst of a family group for their interest and improvement, and would impart to them a knowledge of the minute life of that strange world which the microscope only can reveal.

Figure 49 explains the arrangement of the appa-

FIG. 49.



ratus. It consists of a photographic camera, one of Mr. Carbutt's "Multum in Parvo" Lanterns, with double condenser, and a microscopic attachment.

A word more about this lantern. It is used very largely by dry-plate photographers for the development of their plates, and for various uses in the dark-room. It is most complete and convenient in

its arrangement. It is also convenient for making positives by contact. There are doubtless many other improvements which are being continually made, and which all mark progress in our art. Thus important and sufficient inducement is given to arouse would-be purchasers to the necessity of seeing the latest improvements before they purchase.

B.—INSTANTANEOUS SHUTTERS.

Quidde's Model.—Plates of much higher sensitiveness being now commonly used, the proper arrangement of the apparatus for giving exposures for fractional parts of a second, has become more important than ever. The best known of the many different forms is the drop or guillotine, which is arranged as follows: a board (Fig. 50), with an opening, *O*, is fitted to a grooved carrier fitting on the front jacket of the lens, so that it is free to slip up and down easily. When the board is raised so that its lower part covers the lens, the latter of course is closed. If the board falls, the lens is opened at the instant that the opening *O* passes it, being immediately closed again after it has passed.

At first sight, it would seem that a round opening in the drop was best, but this is not quite the case.

Figs. 50, 51, 52, show three drops with different forms of opening, and the moment is represented when the top edge of the aperture has arrived at the centre of the lens-opening. In Fig. 50 we see less than half of the objective aperture *o;* in Fig. 51 we see exactly the half, and in Fig. 52 more than half

of the lens-aperture. The difference is shown in a still more striking manner just before the conclusion of the exposure, as indicated by the dotted lines. One can easily calculate in this manner that the effect of light of the three shutters in Figs. 50, 51, and 52 with equal movement and all other circumstances identical, stands in the same relation as the

Fig. 50.

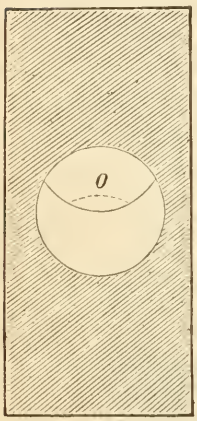


Fig. 51.

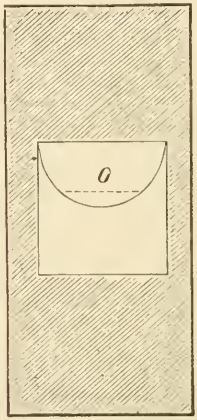
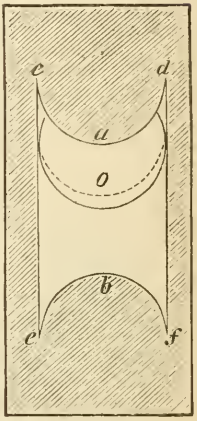


Fig. 52.



superficial contents of the respective apertures, which is approximately expressed by the relation of the numbers 11, 14, and 17 to each other. The latter form of shutter is, therefore, the most advantageous, for it exposes the margins of the picture which have relatively less strength of light, longer than the centre. Both other forms expose the margins of the picture too short a time.

It may be easily understood that every part of the superficies of the lens is uncovered during the time that the opening passes. Inasmuch then as a round

hole is larger in the middle than at the sides, it follows that the sides will not remain uncovered as long as the middle. In the case of the round opening, every part of the lens is uncovered for the same space of time; but in the third form (whose largest dimensions are at the sides), the edges will receive nearly twice as long an exposure as the middle, and consequently the sides of the plate where the illumination is generally deficient compared to the middle, will receive an advantage.

The fall of this simple form of drop can be rendered more rapid by attaching a spring or gum band, so that the traction aids the force of gravity.

Stegemann's Shutter is the same in general principle, except that it works horizontally, the moving parts being controlled by a rubber band. Prümm has proved its usefulness, and *Nickelsen's Double Shutter* (manufactured by Brandt & Wilde, Berlin) is modelled after it. Fig. 53 shows it from the reverse side,

Fig. 53.

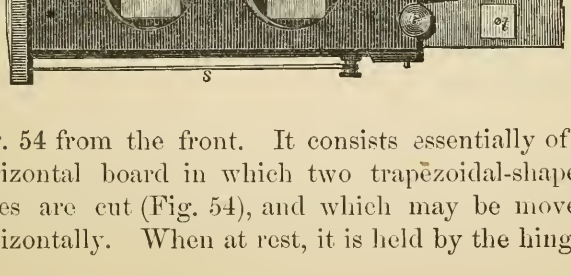
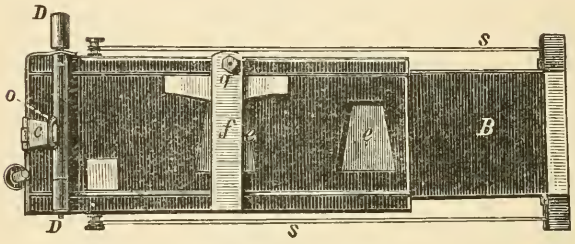


Fig. 54 from the front. It consists essentially of a horizontal board in which two trapēzoidal-shaped holes are cut (Fig. 54), and which may be moved horizontally. When at rest, it is held by the hinge-

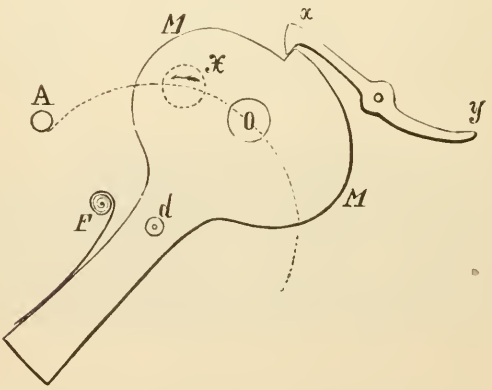
catch, c, which engages in the spindle, o. This spindle is connected with a milled head, D. If D then, be turned with the hand, the catch, c, will be

Fig. 54.



set free, and owing to the tension on the board arising from the gum-bands $s\,s$, c will immediately fall back, and allow the board with its trapezoidal

Fig. 55.



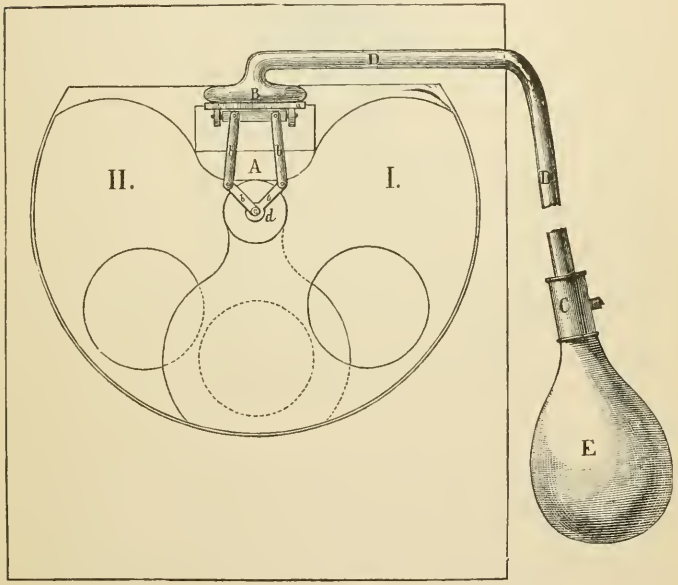
openings to pass the circular opening cut for the lenses (Fig. 53). If a longer exposure is desired, the screw at q is turned, so that the spring at f becomes

pressed down on the sliding board, thus acting as a break, and of course retarding the speed of its movement. The peculiar shape of the openings in the sliding part give a longer exposure to the foreground than to the sky.

The so-called disk-shutters, of which Fig. 55 shows one arranged for astronomical photography (Lehrbuch, p. 461), are moved by a strong spring, *F.* Dreesen of Flensburg uses a round disk with a spiral spring on its axis.

Double Shutters.—These are different in principle.

Fig. 56.

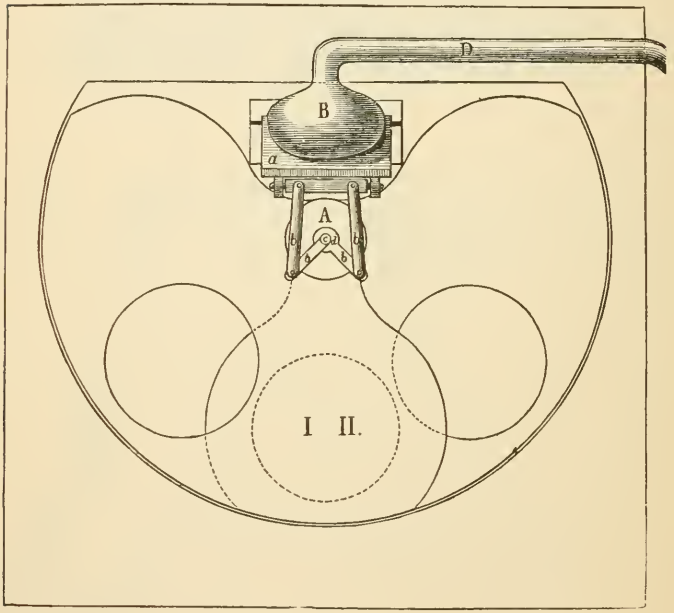


They have two disks with openings, moving in contrary directions past the lens. We select the one

made by A. Moll in Vienna after models by Pizzighelli for explanation here.

The apparatus consists of two rotating disks having a common axis (Figs. 56 and 57), and moving in opposite directions. This motion is caused by a simple lever arrangement, *A*; this in turn is acted upon by pressure from an India-rubber ball, *B*,

FIG. 57.



which is controlled by pressure from the operator's hand on the large ball *E*, this latter communicating with *B* by the flexible tube *D*.

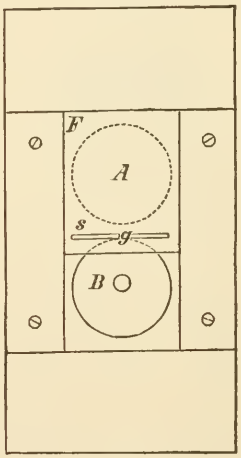
When the large ball, *E*, is compressed, the small one, *B*, is inflated and pressed down together with

the plate *a* which turns on an axis (Fig. 57); the levers *b b* connected at one end to the plate, and at the other to the axes of the disks which are contained one within the other (*c d*), then assume the positions shown in Fig. 57, where they have already caused the disks to move in contrary motion (compare positions of the figures I, II, in Figs. 56, 57. The dotted circle in the middle represents the opening of the lens). The disks may be made to remain in this position until released by pressure on the valve, *C*, which empties the ball, *B*, and allows it together with the plate, *a*, to return to the normal position. If the large ball, *E*, is quickly and strongly compressed, the openings of the disks are driven so rapidly past the lens-opening, that a trotting horse may be photographed perfectly sharp. Gentle pressure thus gives a lenthened exposure, by causing the disks to move more slowly. When it is not desired to make instantaneous exposures, a lever in the woodwork (not shown in the figure) is pushed, so as to bring a peg to bear on the plate, *a*, which then cannot assume the position of Fig. 56, but takes a lower one, so that one of the disk-openings stands directly before the lens-opening. When the exposure, which may be increased at will, is finished, pressure on the valve *c* will return the disks to their former positions. The apparatus may also be made to work for instantaneous exposures of some length, by pressing quickly on the ball with the valve opened.

The great defect in this form of shutter is that the middle of the lens is favored at the expense of the edges. The shutter opens in the middle, and the opening increases in size towards the edges until

the lens is fully opened, when it immediately begins to close again from the edges, so that unless the shutter-opening be decidedly larger than that of the lens, the edges can hardly be said to receive any exposure at all. (Quidde.) This same defect is inherent in all forms of double sliding or double rotating shutters. Pizzighelli has lately constructed another form on the single drop principle. "It consists of a rotating disk B (Fig. 58) with a pin g

Fig. 58.



working in the slit s of the drop. When B turns, the drop is first drawn towards the lens-opening A downwards, and then immediately pushed up again. The quicker B is made to turn (this being done by a spring), the quicker the exposure. It is evident that the lower part of the lens is thus exposed for a shorter time than the upper part, which we must

consider a drawback."[1] (Phot. Corresp. Aprilheft II. 1882.)

P. Zschokke's Instantaneous Shutter has the same fault. The mechanism for controlling the speed of its movement is situated on a board *O P* fitting on the front of the lens by means of a suitable aperture. The apparatus consists of two half disks meeting in the centre. Figs. 59 and 60 show the front, and

Fig. 59.

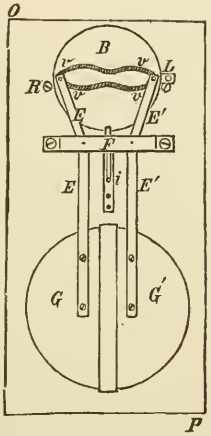


Fig. 61 the reverse side. Figs. 59 and 61 represent it closed, and Fig. 60 open. At the upper end of the board is a stout brass disk *B* rotating on the axle *A*. (Fig. 61.) It has a curvilinear slot *v v v v* in which two pins (attached respectively to the lower

[1] But if the apparatus is worked by a spring, so that it is not dependent upon the force of gravity, why not turn the whole upside down, and thus convert the defect complained of into a positive advantage?—Tr.

elbows of the levers $E\,E\,E'\,E'$) are made to play freely. These levers carry the half disks $G\,G'$, by which the lens is covered, at their other ends. Fig. 59 shows the lens entirely covered by the disks.

Fig. 60.

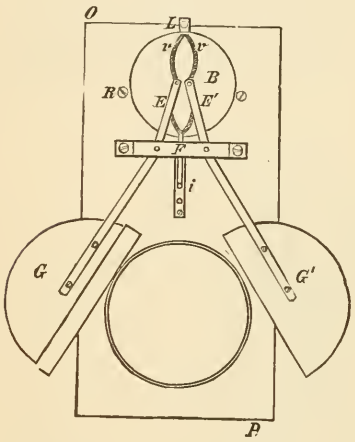
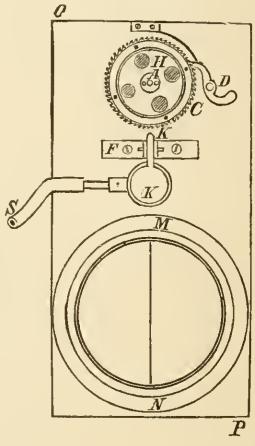


Fig. 61.



But when the disk B turns, the pins on the levers are carried through the curved slot in such a manner that when a quarter of a revolution is made, the lens is fully opened, as seen in Fig. 60, where the two half disks $G\,G'$ have separated. Another quarter of a revolution will bring them together again and so close the lens. On the reverse side of the board $O\,P$, as Fig. 61 shows, is a ratchet-wheel H connected to the axle A, and used for controlling a spring, which may be more or less wound up by turning the wheel. When the disk B is turned, the spring tends to restore it to its former position. If B by means of the button L is caused to make half a

revolution, so that L is brought to the point F, it may be kept there by pressing the catch i (on the reverse side K). Underneath K is a rubber ball connected by the tube S with a large ball in the hand of the operator. (See page 177.) Pressure on the latter, of course, loosens the catch Ki, the spring immediately forces the disk B back, and so the two half disks are separated and closed again, thus making the exposure. The more the rachet-wheel is wound, the quicker the exposure, which may be made to vary from one-half to one-fiftieth of a second. To open the lens so that focussing may be properly attended to, the disk B is turned a quarter and held by the catch; pressure on the rubber ball will release it again and close the lens.

Obernetter used this shutter with great success for his excellent instantaneous pictures of the Schutzenfest, at Munich. (Phot. Mitth., xviii. 8.)

The Universal Instantaneous Shutter of Guerry, in Paris, is constructed on the double-flap principle; it has a pneumatic attachment, and the flaps may either work together or singly. When instantaneous exposures are made, the upper flap opens the lens, and the lower one immediately closes it again. The range of exposure varies from one-fifth to one-fiftieth of a second. When this form of shutter is used on landscapes with time exposures, it frequently happens that the sky is over-done, so that the clouds, which are so valuable in this class of work, have no detail. The trouble can be obviated however, by pushing forward the fork at the side of the case, so that it catches the pulley-cord; by this the closing

of the lower flap is hastened, while the upper one has barely travelled half its distance.[1]

The shutter may be used with the upper flap alone, by casting off the cord from the lower roller. This apparatus may be used in three different ways, and in fact is one of the most convenient known forms. Its action is somewhat slow, so that such subjects as the flight of birds, or express trains at a speed of fifty feet per second, could not be successfully undertaken with it. Becker has made excellent street views with people, horses, and wagons, in the most varied positions, by its aid. Dr. Kayser estimates its average rapidity at one-twentieth of a second.

Measuring the Rapidity of Instantaneous Shutters.—At present there are no convenient means of determining the rapidity of instantaneous shutters. Obernetter suggested a pendulum swinging before a white wall, which when photographed, would leave a sector-shaped image on the film, broader or narrower according to the speed with which it moved, and from which the estimation of the speed of the shutter may be calculated. But this is not entirely reliable, from the fact that the speed of the pendulum is not the same in all parts of its course. A chronoscope would do good service here, but such an instrument is seldom at hand, and would be too expensive for a single experiment.

The author is inclined to the opinion that a sounding siren with pointer would be useful for these cal-

[1] As this would manifestly *increase* the exposure given to the sky, the translator suggests that a simple reversing of the apparatus will bring about the desired end. Compare note, page 181.

culations. As the pointer turns quickly and with great regularity, a photograph of it made with the instantaneous shutter could as in the former case, be made to show a broader or narrower sector, according to the length of exposure.

Reichard proposes a very simple means for the same purpose. Any clock acting *with weights* is set up in a suitable position, and after removing the escapement, it is wound up and allowed to run down. The hands will move evenly and with a speed depending on the weights used; this may be quite easily determined. The dial is then photographed with the shutter, and the exposure calculated from the distance travelled by the minute hand.

It has been objected to this, that the speed of the hands is not even, but gradually accelerated. (Phot. Mitth., xxi. 54.) The British Journal proposes another method, by adapting a slip of card blackened with lampblack to the falling part of the drop, and on which a tuning-fork carrying a pointer is made to register its vibrations; this of course could not be applied to flap shutters. Dr. Kayser has used Atwood's Gravity Machine for these calculations, with excellent success. As the machine may easily be made to give a falling body a known rate of speed (about twenty-seven inches per second), the body may be photographed and the rapidity of the shutter registered to one one-thousandth of a second. (Phot. Mitth., xix. Juliheft ii.)

Boca's Shutter.—This invention of a Parisian has the peculiarity of permitting the exposure to be measured. It has a clock movement with a hand

traversing the dial in three seconds. The dial is marked off in three parts, each part being subdivided into 50° of which each one represents one-fiftieth of a second. The shutter itself consists of two disks rotating in their own planes by a spring-motor; one opening the lens and the other closing it. The exposure is made by pressure on the button that starts the clock-work and the disks together, the hand on the dial pointing to 0. If exposures of the $\frac{2}{50}$, $\frac{3}{50}$ or $\frac{4}{50}$ of a second are desired, the hand is made to point to the first, second, third, or fourth degree from the 0 before starting.

This shutter has not yet been seen in Germany, so that the author can give no opinion of its merits. The Phot. Correspondenz, 18, p. 205, gives a descriptive figure of the apparatus.

Addenbrock has lately constructed a similar form of shutter. We doubt whether the clock movements can be depended upon as absolutely accurate from the moment of their first starting, so that errors in the determination of very short exposures would occur.

The impulse given to amateur photography by the dry-plate process becomes more marked day by day. The professional photographer, however, need not fear any breakers ahead on that account, for good amateur work only serves to lead to a better appreciation of photography, just as in the musical world there exists a truly harmonious relationship between the amateur and the professional musician. Nowhere are amateurs in music more plentiful than here in Germany, and yet in no other country are professional musicians better contented than here.

The mistakes amateurs mostly make are: Miscalculated time of exposure, injudicious use of the stops, and incorrect development. In regard to the stops, it is also a grievance for the professional photographer that he does not know the relationship of the stops as to size. If he knows that a stop which belongs to an objective is one-half or one-third as large as another, he knows also that it is necessary to expose with the same four times, respectively, nine times as long as with the other. It would be well for the optician to mark the relationship of the stops as to size always on the stops, or better still, to give the respective time of exposure of the separate stops; if for the largest stop, one second is sufficient. This could be easily expressed by a number inscribed upon the stop. I have made calculations with this object in view, for some objectives which are now very much in favor for dry-plate photographing, also for Steinheil's Aplanatic and Voigtländer's Euryscope. The following table indicates the time of exposure for the several stops: if for the largest stop, one second is required;

Stops.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Steinheil's Aplanatic,	1	$1\frac{1}{3}$	$2\frac{1}{2}$	$3\frac{1}{2}$	9	18
Voigtländer's Euryscope,	1	$1\frac{1}{2}$	$2\frac{3}{4}$	6	12	26

It has, however, been remarked that the new Voigtländer Euryscope possesses at least one and a half times more strength of light (when used with full aperture), than the old Steinheil, and if with the latter one second is required, two-thirds of a second suffice with the former.

At no time before were so many instantaneous shutters bought as in this year. With the instan-

taneous shutter it is of special importance to know the time of exposure, and different methods have been in practice thus far. Dr. Keyser, the assistant of Hemholtz, says:

"An exact determination may be arrived at by two different ways, according to the construction of the shutter. If the exposure is done by an aperture, with fixed margin no matter whether in slit or circular or any other form being passed before the objective, the easiest and simplest way to determine the time of exposure is to have an electric circuit opened and closed by the slit-margin when in motion, and to measure the time intervening between opening and closing by the chronograph."

This method, however, is not practicable with another kind of instantaneous shutter, which has a simultaneous movement of two wings or lids, as for instance the Guerry or Pizzighelli shutter. With these shutters it is best to photograph an object, the velocity of the movement of which is known, and to determine the time from the distance a given point in the picture travels. It is best to select for this purpose an object which moves with uniform velocity, for a pendulum in motion which is used by Obernetter for the same purpose, gives much less satisfactory results.

In experimenting with Guerry's shutter, I used an Atwood "slider," by which, as is well known, any desired uniform velocity may be imparted to a falling weight. In my experiment, I gave the weight a velocity of 27.003 inches per second, which is sufficient to determine a thousandth part of a second with sufficient precision. Guerry's shutter is moved

by pneumatic pressure, and as the time of exposure depends therefore upon the velocity with which the caoutchouc balloon can be compressed, the time of exposure will therefore depend again upon the personal dexterity of the manipulator. With the quickest possible compression, I found the time of exposure to fluctuate between 0.0555 and 0.0635 second, that means a little more than $\frac{1}{20}$ second. The length of the pipe between balloon and shutter exerted no influence, and the time was also not shortened by tightening the pipe at one spot with two fingers and compressing the balloon and then suddenly opening the fingers again, by which manipulation the exposure is apparently shortened.

I have made these additional remarks on shutters in order that my amateur friends may be fully and freshly informed on the subject.

CHAPTER VI.

THE NEW PHOTOGRAPHIC PROCESSES

A.—NEW NEGATIVE PROCESSES (DRY PROCESSES).

The Gelatine Process.—The Chemical Part has already spoken of the great increase in the use of dry plates since the year 1878. The gelatine process, which had only a short chapter devoted to it in the Lehrbuch, page 378, has been so improved that, with its sensitiveness and simplicity, it has exceeded the wet-collodion process, and would doubtless drive out the latter altogether were it not for the fact that gelatine plates are relatively high in price, and have certain disadvantages, such as the tendency of the film to frill and loosen in the more or less warm water necessarily used during summer and in hot climates, as well as the difficulties attending the intensification and thorough removal of chemical matters from the film by washing.

But the amateur and the traveller, to whom the price is of secondary importance, will undoubtedly prefer the gelatine plates to wet collodion on account of the easy manipulations and cleanliness with which they may be handled and used, particularly now when the commercial manufacture of the plates precludes this troublesome step in the process on the part of the operator.

1. The Practice of the Gelatine Emulsion Process.

Gelatine Plates. — If we were writing only for amateurs, we should not speak of the preparation of gelatine plates, but refer the reader to the manufacturers. The gelatine process has the peculiarity that the sensitive fluid used for coating the plates (gelatine emulsion) will not keep very long, but must be used up soon after it is mixed Again, successful coating of the plates demands manipulations and special apparatus not necessary for collodion plates, and finally, the drying is a very tedious business, for which properly ventilated and dry rooms are a *sine qua non*. Many photographers then will not care to undertake the preparation of the plates themselves, not having suitable laboratories, nor the time and endurance. For these reasons, not only amateurs but also many of the professional class order their plates ready prepared, and the *manufacture of gelatine plates* is now an important branch of photographic industry. To the best of our belief, we have three establishments of the kind in Berlin, two in Frankfurt a. M., and one in Munich. Many plates, too, are imported from England and Belgium.

Vogel's Emulsion.—A preparation has lately appeared in the market, which, besides the keeping qualities of iodized collodion or collodion emulsion, combines the easy manipulations of the latter with the high sensitiveness of the gelatine plate, so that now any photographer is enabled to prepare dry plates having a high degree of sensitiveness in the same manner as collodion plates, and very easily. This is the author's emulsion. Plates are coated

with it like collodion; they dry within an hour; and are as easy to develop, fix, intensify, and wash as collodion plates. This emulsion consists of a mixture of collodion and gelatine (a solution of gelatine and pyroxyline in glacial acetic acid and alcohol, see page 87) in which the very sensitive bromide of silver is present in a fine state of division. The only drawback to this emulsion is that it is difficult to manufacture, and that it gives off the fumes of acetic acid when used. But the author has lately succeeded in reducing the acid to a minimum (formerly 50 per cent., now 10 per cent.), so that it is scarcely perceived when working. Further details are given below, gelatine plates next claiming attention.

Keeping Qualities of Gelatine Plates.—Photographers have become more and more inclined to take the preparation of plates for their own use into their own hands. Even if the emulsion itself does not keep, the coated plate has the advantage of keeping indefinitely if good gelatine has been used. Nevertheless, cases are reported where decomposition of the plates had set in soon after preparation. Prümm is very positive on this point (Phot. Mitth., 1881, 156), and, although he was at first almost alone in the opinion, the author was soon compelled to agree with him. He obtained a batch of gelatine plates from a manufacturer of reputation in order to make comparative trials with his own emulsion. The gelatine plates had evidently been cut down with the diamond from a larger size, and at first were all that could be desired. After nine months had elapsed, the sensitiveness remained the same, but

there were unmistakable signs of decomposition at the edges, and gradually working in towards the middle of the plate. Nothing could be seen before developing, but at this stage of the process a black, vignetted halo started at the edge and encircled the whole plate. This has been frequently observed by professional photographers when using commercial plates, and is always a sign of commencing decomposition. But the author does not wish to insist that *all* gelatine plates decompose in this manner, for he has some two years old that are still perfect. But the fact sufficiently discloses a grave difficulty in the gelatine process—the decomposition of the gelatine. It may be that the real reason will depend upon the particular emulsifying process employed for a particular sample of gelatine (*e. g.*, all gelatines would not bear the ammonia process of Eder; this process has been tried by many, and, after some few successes, again laid aside), or the drying of the plate has been allowed to occupy too long a time. Of course, the decomposition may possibly be traced back to the factory where the gelatine itself is made, carelessness in selection of the raw material or commencing decomposition in the drying being quite enough to ruin everthing. But it can be positively asserted on the other hand that, since manufacturers like Heinrichs and Simeon (Höchst a. M.) have offered gelatines specially prepared for the emulsion process, the quality has much improved. Still different samples will be found to vary very much, some being harder, some softer, etc.

Preparation of Gelatine Emulsion.

Different Methods.—The methods by which the gelatine emulsion may be prepared have naturally divided themselves into three heads:

(1) *By Digestion.*—Here a warm solution of bromized gelatine is treated with nitrate of silver solution, and the so-obtained emulsion of slight sensitiveness is kept fluid at a temperature of about 100° F. for several days, by which the sensitiveness is increased. This method is the oldest.

(2) *By Cooking.*—Gelatine emulsion is prepared as in (1), or even at 145° F. It is then heated for from half an hour to an hour so as to obtain sensitiveness.

(3) *By Ammonia.*—By this method the bromized gelatine is either treated with ammonio-nitrate of silver, or, as is perhaps more usual, emulsion prepared as in (1) or (2); is heated for a short time only, cooled off, treated with ammonia, and carefully digested at a medium temperature so as to form the *blue-sensitive bromide of silver* (see page 57).

The other methods of which we may soon proceed to speak, and which have recently become known, cannot be said to have been generally employed.

We may mention, however, the combined methods, such as treating emulsion prepared as in (1) or (2) with ammonia, or digesting already cooked emulsions (Eder). Indispensable conditions are: 1. *That the gelatine solution be kept acid by glacial acetic acid.* 2. *That the gelatine and bromide be first mixed, and the silver afterwards added, but not the reverse.* 3. *That*

only a portion of the gelatine be used for the actual emulsification (*i. e., the mixing of the bromide and silver*), *the rest being added after the cooking or digestion.* 4. *That an excess of the soluble bromide* (*preferably bromide of ammonium*) *be present.* For even when this salt is partly broken up during the cooking (see page 81), the action is favorable, owing to the formation of free hydrobromic acid. Eder recommends chemically pure bromide of potassium as made by Schuchard, of Görlitz.

The reason for 1 is that an alkaline reaction, particularly if the gelatine be not quite pure, will reduce the bromide of silver, and so cause fog.

The reasons for 2 and 4 are that nitrate of silver acts badly upon gelatine, causing "red fog" when the developer is applied.[1]

[1] Abney, however, has successfully tried the process reversed (silver dissolved with the gelatine, and bromide of ammonium afterwards added). He claims to have thus made a fine emulsion with no tendency to red fog, which as stated above, generally appears under these circumstances. (Photo. with Emulsions, II. Edition, 142.) The apparent contradiction (see also p. 60) is explained by the fact that Abney adds an excess of bromide so that every trace of free nitrate is destroyed. He further says (Ibid., p. 117) that a large excess of soluble bromide increases sensitiveness. Wilson even declares that in the presence of a large excess of soluble bromide, the highly sensitive variety is *more quickly* formed. (Ibid.) Eder dissents from this. Wilson says "the less bromide, the longer the cooking." If both salts were present in their combining proportions, according to Wilson then, the highly sensitive variety would not be formed even with long cooking. This does not coincide with the author's experience. He cooked half of a batch of emulsion prepared with an excess of bromide of ammonium without heat before washing, and the other half after washing. The latter was decidedly the more sensitive. But Wilson says that a very large excess of bromide causes fog that cannot be removed with bichromate of potash.

The reason for 3 is that gelatine when heated becomes more fluid and loses its setting power (page 85); it has also been remarked that the "ripening" (formation of the highly sensitive variety, page 57) goes on more quickly in a weak gelatine solution than a strong one.[1]

With regard to the practice of the three methods, it should be said that ammonia increases intensity as well as sensitiveness (page 58). Where this quality is desired, the ammonia method will have strong claims. It is more troublesome though, and requires *very pure, hard gelatine* (see tests on page 88), inasmuch as some of the setting power is lost under the action of the ammonia.

The quantity of gelatine varies very much in the formulæ of different writers. We use 1 part of gelatine for 1 part of bromide of ammonium. Eder, from 1½ to twice the amount. Abney, 19 parts of gelatine to 15 parts of bromide of ammonium (with iodide of potassium). The harder the gelatine, the less is needed: while the reverse is true of the soft samples. The operator therefore must be guided by circumstances. The author has found that it is possible to reduce the quantity of gelatine to two-thirds of that of the bromide of ammonium. A further decrease injures sensitiveness. Eder says

[1] Directly opposed to this is Eder's observation, lately sent to us by letter, that an emulsion thick with gelatine, when cooked at 212° F., acquires great sensitiveness. He gives the following formula: Dissolve 370 grains of bromide of potassium with 308 grains of gelatine in 7 ounces of water; treat with solution of 462 grains of nitrate of silver in 4 ounces 3 drachms of water. After cooking from 30–40 minutes, add 308 grains of gelatine in 14 ounces of water. (See page 221.)

(Theorie u. Praxis der Phot. mit Emuls.): "A relatively small percentage of gelatine has the advantage of (1) not causing the emulsion when broken up for washing to imbibe an excessive amount of water; (2) a smaller amount of this emulsion, rich in bromide of silver, may be used for coating the plates, and yet give opaque creamy films which dry easily and adhere tightly to the glass. Very thick films have a tendency to frill during development and loosen away from the glass. Too little gelatine causes the bromide of silver to become very coarse, so that it will not remain in suspension, but gradually falls to the bottom of the bottle." Van Monckhoven rightly observes that an increased quantity of gelatine gives soft pictures, and a diminished quantity very intense or even hard results.

Abney always uses two kinds of gelatine, say 1 part of Simeon's hard variety to 3 parts of Nelson's soft No. 1. The soft variety facilitates development and fixing. (Phot. with Emuls., ii. 136.) When very hard gelatine is used the plates develop slowly; glycerine will here serve a useful purpose (page 86).

Addition of Iodides and Chlorides. — Page 67 has already spoken on this point; Eder's latest investigations have confirmed our views in the main. (Phot. Corr., xix. 149.)

Iodide of silver manifests an injurious influence only in the case of digested or cold-prepared emulsions (such as loss of sensitiveness, thinness of the negative, tedious development; Eder). *This influence may be lessened by longer digestion or cooking.* He saw this when $\frac{1}{50}$ part of iodide of silver was present,

but states that it is more evident with the ferrous-oxalate than the pyro developer; and the iodide seemed to confer *greater brilliancy*.[1] He also adds that iodo-bromide emulsion (with $\frac{1}{50}$ iodide of silver) cooked for half an hour, then treated with ammonia for half an hour at from 90°–105° F., gives more vigorous negatives than one without the iodide. This circumstance explains the more favorable results always obtained by the author with iodide of silver, for he generally used the boiling and the ammonia methods combined. All of Vogel's emulsion that has appeared in the market contains $\frac{1}{12}$ part iodide of silver, and equals the best gelatine plate in sensitiveness. While iodide of silver slightly retards development, this latter is hastened by small additions of chloride of silver (Eder).[2] This authority does not recommend the addition of soluble chloride during the preparation of the emulsion, but rather that $\frac{1}{20}$ to $\frac{1}{10}$ of gelatino-chloride emulsion be added to the former when prepared.

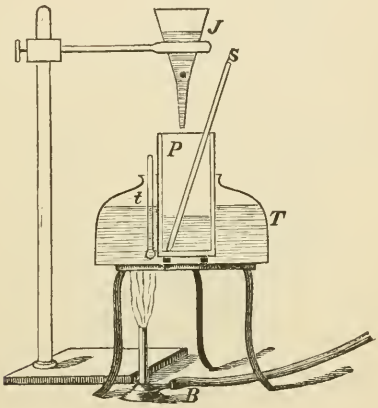
[1] The addition of freshly prepared (*i. e.*, uncooked and unripened) emulsion to one already ripe has the same effect as the addition of iodide of silver. (Eder.)

It may be well to mention that Schumann holds that iodide of silver increases not only the sensitiveness to daylight, but also to the feebly refrangible rays in a marked manner. This is opposed by Abney, Eder, and Vogel. (Phot. Archiv, 1882, pp. 98 and 121.) The assertion, although supported by experiment, must be received with caution.

[2] Eder also claims that the addition of other easily reducible salts increases sensitiveness *even after exposure*. A gelatine plate dipped in weak nitrate of silver solution and dried (after exposure) was twice as sensitive as an ordinary plate; but spots and defects appeared. Arsenite of silver has a similar effect.

The Apparatus.—For the preparation of gelatine emulsion a water-bath is indispensable. The author makes use of an ordinary tea-kettle when experimenting on the small scale. Fig. 62 shows the arrangement. *T* is the kettle filled with water and heated by the Bunsen burner *B*. *P* is a porcelain jar such as apothecaries use for keeping medicines in (the cover is not seen in Fig. 64). *J* is a funnel

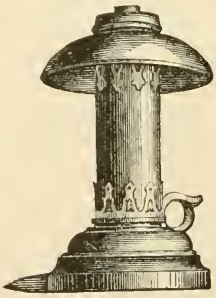
FIG. 62.



having its neck stuffed with cotton, so that hot water (with which it is first filled) drops into the jar at the rate of 3 or 4 drops per second. *S* a glass rod for stirring, *t* a thermometer. We prefer the porcelain jar rather than glass flasks or vessels as generally recommended, as it is not so likely to break. For 7 ounces of emulsion then, let a jar holding 14 ounces be selected, and one about twice as deep as it is broad. If gas is not to be had, a powerful Berzelius lamp, petroleum cooking-stove, or charcoal fire with

bellows and good draft may be substituted. It need scarcely be said that the apparatus must stand in the dark-room. For illumination a lamp with red chimney (Fig. 63) may be used.[1] *During the addition of the silver, and in fact, as long as there is an excess of bromide present, it is not necessary to be over-cautious about the light*, for the bromide keeps down the sensitiveness considerably; but when the perfectly washed, highly sensitive emulsion is to be handled, then care is necessary, and the direct light of the lamp should not be allowed access to it *longer than is absolutely necessary*. At the distance of three feet, a few minutes will do no harm. The ceiling of the room should be painted black in order to prevent reflection from the lamp. (Fig. 63.)

Fig. 63.



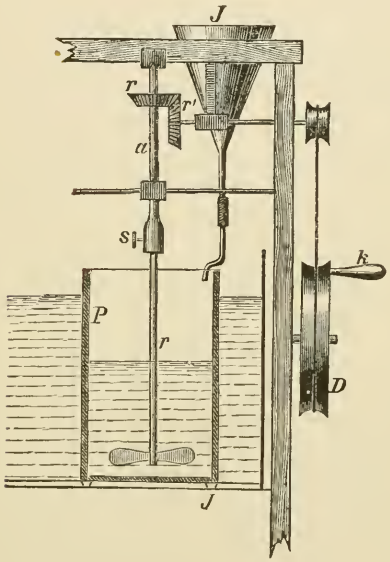
In this manner we have made as much as two quarts of emulsion. If larger quantities are to be prepared, we advise a hollow tin case to be adapted around the funnel and filled with hot water; this

[1] Suitable ones are kept by the stock-dealers.

will keep the silver solution warm. Of course, larger water-baths will also be required.

The author has also introduced a stirring apparatus for quantities of two quarts and upwards. It

Fig. 64.



consists of a hard-rubber stirrer, *r*, dipping into the solution in the jar *P*, and turning on a vertical axis supplied with a bevelled wheel, *r r'*. The axle of the latter is connected with a multiplying wheel and handle, *D k*. For preparing large quantities of emulsion we recommend steam-heating, but if the above apparatus be placed over a fire, it will be well to support the jar *P* on two iron supports, so that the hot water can circulate under the bottom; other-

wise, the bromide of silver may cake fast to the bottom, owing to its being more heated than the sides.

(A) The Author's Methods.

We will now proceed to give the manipulations used by ourselves in the laboratory, as the result not only of our own experience, but also that of others.

1. *The Silvering.*—We have already pointed out (page 50) that silvering at a high temperature gives an emulsion considerably more sensitive than the same if carried out at a lower one; 140°–163° F. is the temperature now almost universally used; 105° and under is only used in conjunction with ammonio-nitrate of silver.

We begin by putting 185 grains of bromide of ammonium (or from 181 to 169 grains of the same with from $\frac{1}{4}$ to 1 part of iodide of potassium), 31 grains of Simeon's or Heinrich's gelatine, and $3\frac{1}{2}$ ounces of distilled water into the porcelain jar, *P* (Fig. 63), and then put the whole into the kettle, *T*, previously warmed to about 168°. The water in the kettle should not quite reach the boiling-point.

We then weigh out 123 grains of gelatine and put it to soak in cold distilled water, in a beaker-glass or cup, until the operations of silvering and cooking are finished.

308 grains of crystallized nitrate of silver are dissolved in 25 drachms of water in a flask, and set to heat in a separate water-bath at 168°.

Both solutions are now to be tested with litmus-

paper[1] (*i. e.*, the bromized gelatine and the silver). If the silver shows an alkaline reaction (generally the case), or the gelatine (rarely), from 2 to 4 drops of glacial acetic acid are to be added to each solution, and the test with litmus-paper again applied. If both show the *acid* reaction, the temperature of the gelatine solution is to be taken with a *clean* thermometer. If it exceeds 140°, the silvering may be started (in the dark-room); care being taken that the silver solution be warm when it is poured into the funnel, that the water-bath be kept up to 168°, and that *the mixture be well stirred.*

2. *The Cooking.*—Fifteen minutes will generally complete the silvering process. A few drops of water are poured on the cotton-plug in the funnel to carry down the last traces of silver, and after repeating this once, the plug is removed and the heat raised sufficiently to make the water-bath boil. When the thermometer shows 207°, the cover is set on the jar (without removing the glass rod), and the boiling continued for from 1½ to 2 hours, according to the degree of sensitiveness required.

The mixture should be stirred from time to time. Sometimes a deposit of bromide of silver forms and cakes together, but becomes diffused again on stirring. We have not noticed any bad effect following this deposition if thorough agitation of the mixture was resorted to. Some writers maintain that if iodide of potassium is to be used, it should only be added when the greater part of the bromide of am-

[1] Red litmus-paper is held over the mouth of a bottle containing ammonia until the blue color is restored. In this condition it is most sensitive.

monium has been converted; but we have always been in the habit of adding it at the beginning.

The sensitiveness of an emulsion prepared in this way with 1½ hours' boiling is certainly three or four times that of wet collodion. (The sensitiveness of a *cold-prepared gelatine emulsion* before ripening is about one-third that of the same.) After the boiling is finished, the rest of the gelatine is added (123 grains) after draining off the water as closely as possible, the jar having been taken out of the water-bath, and the whole well stirred again for a couple of minutes so as to dissolve the gelatine.

Abney states that the second part of the gelatine should be added to the cooked emulsion after the latter has been cooled off. He says, "if it be added while hot, it will give shiny films: if cold, matt films; the latter are to be preferred." (Phot. with Emuls., ii. 156.)

The jar containing the emulsion is then stood in cold water (in summer, ice-water).

To test the quality of the emulsion thus prepared, a few drops may be taken out with the glass rod, placed in a test-tube, allowed to set, and a solution of neutral (yellow) chromate of potash poured on. If the mass assumes a rosy, flesh-colored, or red tint, there is an excess of silver present (probably due to an error in weighing), and the emulsion is spoiled. Two test-plates also may be coated: take two 3 by 4 inch clean glasses, lay them on a levelling-stand (*i. e.*, a small, three-legged table furnished with screws so that it can be levelled accurately), and pour upon each one about a drachm of emulsion. This may be conveniently removed from the jar and applied

to the glasses by means of a pipette. The emulsion is spread over the glass with the glass rod and allowed to set. The plates are then laid in a bowl of water and set under the tap for an hour; after which they are rinsed twice with distilled water, and finally dipped in alcohol of 80° for 5–10 minutes. They are then stood up in the dark-room to dry, which is generally effected within an hour, when they may be tested and compared with any plate of known good quality.

The test is best made with a stereo-camera, exposing the plates side by side for an equal time, and developing in the same bath (preferably with pyrogallic acid). A plaster-bust with black-cloth background is a suitable subject. It should not be forgotten that if a hard sample of gelatine has been used, the image appears slowly in developing, so that the plate might be thought less sensitive than it really is. Its behavior under long-continued development is to be closely watched. (For testing with the photometer, see page 135.) If the plate has sufficient sensitiveness, and *freedom from fog* (the chief desideratum), the emulsion—which has by this time been in ice-water for two hours, and is firmly set (in warmer water longer)—may now be continued with.

3. *The Pressing.*—The emulsion still contains salts in sufficient quantity to be injurious; nitrate of ammonia (product of the double decomposition of nitrate of silver and bromide of ammonium), and an excess of bromide of ammonium. Both must be removed, and this is done by washing; but it is not an easy matter to wash the gelatine thoroughly; even

when subdivided in bulk, it requires much more washing than collodion. To get it into this condition, it is best to press the jelly-like mass through *canvas*, *i. e.*, the coarse kind with large meshes, such as ladies use for embroidering. The meshes may be rather less than one-sixteenth of an inch in size. If larger, the individual pieces will be larger also, and require longer washing. According to Eder, pieces of this size can be washed in three-quarters of an hour; when the meshes are three times the size, not under one and a half to two hours.

To conduct the pressing, a piece of clean canvas should be spread out over a vessel containing water of not more than 55° F. (for the above quantity a quart jar will do). The hands having been carefully rinsed off with *very weak* nitric acid, and dried with a clean cloth, the jelly is then to be transferred to the canvas, after first loosening it well away from the sides of the jar with the glass rod. The canvas is now folded up like a bag and the lowest point seized and held with the right hand, while having plunged it into the water it is forcibly turned with the left, so that the gelatine is squeezed through.

The pieces soon settle to the bottom of the jar (5–7 minutes). If the supernatant water is milky, it is evidence of the gelatine having been decomposed during cooking; but is by no means a sign that the emulsion is useless. Soft water should be used throughout both of these processes. Hard well-water is unsuitable.

4. *The Washing.*—After the emulsion has settled, the water is drained off into another vessel so as to catch any stray particles that would otherwise be

lost. A second change of water is now poured on the emulsion and well stirred up with the glass rod; the whole again allowed to settle, and this is repeated six times. Finally it is treated with distilled water twice, and tested for free soluble bromide by adding a few drops of a ten per cent. solution of nitrate of silver to the last drainings from the emulsion. If a decided milkiness is seen after a few minutes' standing, the washing must be continued (with distilled water), until it no longer appears.[1]

The author has succeeded in this way with quantities measuring more than two quarts. Attempts have been made to simplify the process by washing-machines, but these have disadvantages.

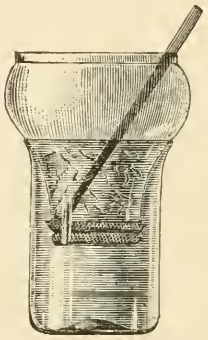
The divided emulsion is best put into a large bag made of coarse silk, and hung over a cross-stick in a small tub or capacious glass vessel. If the tub is very roomy, two hours' washing with two changes of water and an occasional shaking up of the bag will be enough. With smaller vessels, four changes may be given. Schumann's apparatus (Eder) is also very practical (Fig. 65). A pear-shaped bell-glass is covered at its narrower end with stout muslin to support the emulsion, and the whole set in a roomy beaker, as seen in the figure. To change the water it is only necessary to lift the bell-glass, when, by slightly agitating it, the water drains off through the muslin. The beaker is then emptied and refilled with fresh water.

Costly and complicated affairs for washing in run-

[1] It may be remarked that emulsions prepared with bromide of potassium are more difficult to wash than those prepared with bromide of ammonium. (Eder, Phot. Corr., 1881, p. 96.)

ning-water have also been made, but they are not necessary. For operations on the small scale, a large china or porcelain tea-pot (*not metallic*), does

FIG. 65.



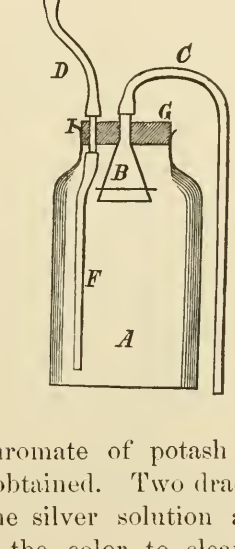
good service. The cover is replaced by the layer of silk, and a rubber tube carried from the tap to the spout; the water after circulating through the pot escaping through the silk fold. The emulsion is kept constantly moving and is washed very quickly. (Eder, Phot. Corr., 1881, 99.)

Turnbull's washing apparatus,[1] or one on the same principle, may be made of any size; its construction is easily understood from Fig. 66. The water is conducted to the bottom of the vessel by the tube *D F*, flowing off again through the funnel *B*, closed with silk, so as to prevent the escape of the small particles of emulsion, the tube *c* serving as the outlet. (Fig. 66.) Eder holds that an emulsion which still contains 0.1 per cent. of soluble bromide, has been sufficiently washed. He recommends this test

[1] Phot. News, April, 1881, xxv. 180.

for the washed emulsion: prepare a solution of exactly 61⅔ grains (4 grammes) of nitrate of silver in 2.1 pints (1 litre) of distilled water. Three hundred and eighty-five grains of the emulsion in the liquid state are weighed out, diluted with four or five volumes of distilled water, and after cooling treated

Fig. 66.



with yellow chromate of potash until a distinct yellow tint is obtained. Two drachms 50 minims (10 ccm.) of the silver solution are then added, which changes the color to clear reddish-yellow or deep red if the emulsion has been sufficiently washed.[1] Very well washed emulsions strike the

[1] 10 ccm. (2 drachms 50 minims) of the silver solution correspond to 0.028 gramme (about $\frac{2}{5}$ of a grain) of bromide of potassium, or 0.023 gramme (about $\frac{17}{50}$ of a grain) of bromide of ammonium. Under the above conditions, the test will show the presence of soluble bromide in quantities over 0.1 per cent.

red color with 85 minims of the silver solution, and then contain less than 0.05–0.06 per cent. of soluble bromide. But if 340 minims of the silver solution strike no red color or even no change of color at all, it is proof of insufficient washing.

This test can only be used with neutral aqueous emulsions. Those containing acetic acid must first have it removed or neutralized.

The whole analysis may be made by daylight, though candle or gaslight will also enable the change of color to be distinctly seen. (Phot. Corr., 1881, p. 99.)

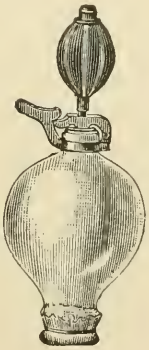
A trouble with all forms of washing apparatus is that the pores of the muslin used for straining soon get stopped up. The pressing canvas should be thrown into hot distilled water immediately after use, well kneaded about, and then rinsed three times in hot water until there is no further milkiness. This is best done in the dark, for the light soon turns the stuff brown, and it can only be bleached again with weak acid (1 part nitric acid, 100 parts water). All the cloths used for filtering are cleaned in the same way.

5. *Draining and Filtering.*—When the emulsion has been washed enough, the water that remains after pouring off is allowed to drain away closely. The vessel containing the jelly is then tied over with cotton cloth and inverted, so that the draining goes on spontaneously. The vessel is then set in water at about 120° until the emulsion is melted. It might now be used for coating, except that occasional splinters of wood in the gelatine or dust in the salts still remain. These are removed by strain-

ing through thick cotton cloth or washed cotton fitted into a funnel. But the funnel must be kept warm so as not to allow the gelatine to set. Special arrangements for this purpose, such as a metal case carrying hot water and applied around the funnel, are very convenient. The emulsion will soon choke the filter; this must be helped out by occasionally working the cloth gently to and fro.

Braun's pneumatic filters have lately come much into favor. They consist of a glass balloon tied over with chomois-skin below, and fitted above with a valve and rubber pumping ball (Fig. 67). The

FIG. 67.



opening in the neck having been uncovered and the emulsion poured into the previously warmed balloon, the filtration goes on by pressing the ball (the cap fitting on the opening of course being replaced).

The filtered emulsion, which will keep eight days in cool weather, may now be used for coating. Antiseptics such as thymol are better not added;

they usually affect the sensitiveness somewhat, and their effect does not continue for any length of time. Eder advises the addition of 170 minims of a solution of 15 grains of salicylic acid or thymol in 850 minims of alcohol to every $3\frac{1}{2}$ ounces of emulsion. The alcohol aids the drying. If *permanent gelatine emulsion* is desired, the small pieces are allowed to dry (page 220). This is now a commercial article, and merely requires to be dissolved in warm water. The emulsion should be used up soon by coating plates.

6. *Coating the Plates.*—The author invariably gives his plates the substratum of insoluble gelatine[1] first proposed by himself. It is simpler than polishing the glass, and increases the adhesion of the film in a remarkable manner. Dissolve 15 grains of gelatine in 9 ounces 5 drachms of warm water; filter, and add after cooling, 102 minims of filtered chrome alum solution, 1 : 50. This keeps from 4 to 6 days, or for some weeks if a few drops of carbolic acid be added. The plates are first to be soaked in acid, then washed and well rubbed off, and laid in a pan of filtered distilled water. They are then taken out, drained, and a portion of the gelatine solution poured on, made to pass quite over the plate and run off to waste. This merely displaces the surface water on the plate, and is therefore followed by a second portion, after which the plate is set up perpendicularly to drain and dry, which will take place

[1] After trial of aceto-alcoholic, chrome-gelatine, and the simply aqueous solution, we have settled upon the latter as not requiring such careful cleaning of the glass as the former. (Phot. Mitth., xviii. p. 44.)

within an hour if the room is not too cold. In winter this should be done in a warm room, as cold plates take the gelatine with difficulty.

The author lays the dried plates, with the prepared side up, on a levelling-stand, and then pours on the emulsion (about 2–3 drachms for a 5 x 8 inch plate). It is carefully spread over the plate by means of a glass rod bent at a right-angle. It will be found convenient to use a porcelain spoon, or a pipette holding the proper quantity for each plate. The latter also may be fitted into the cork of the emulsion-bottle. This must never be shaken, lest air-bubbles be formed. The pipette is filled by suction at the upper end, and the emulsion kept there by pressing the finger firmly down. After the plates have set, they are stood vertically in a plate-rack to dry. Some operators coat and flow off like collodion (Obernetter; Dr. Schnauss).

Obernetter uses a substratum of silicic acid, 1 : 200. He says, "The emulsion runs like collodion over a plate thus cleaned, and is applied in the same manner by the aid of a plate-holder. The excess is run off from one corner into a suitable vessel, and stood again in hot water. The emulsion remaining on the plate is evenly distributed by rocking the plate to and fro. Care must be taken not to pour on too little, or else the picture will be deficient in vigor. The opacity of film should be about that of a heavily iodized collodion plate. The coated plate is then to be laid on an absolutely level slab of glass, stone, or metal, which should be kept as cold as possible. The emulsion sets in 2–5 minutes, and after this the plate may be set up vertically to dry."

A flat dish should be set underneath to catch drops of the emulsion, or any running off from the corners. A high temperature causes less to remain on the glass, a low one the reverse. Thus the emulsion may be used up to the last drop. For 100 5 x 8 inch plates, slightly less than 25 ounces of emulsion will be required. The level slab should be large enough to hold at least six plates side by side. When the sixth plate is coated the first one will be firmly set and ready to be moved into the drying-box. The plates may be set vertically in the drying-box where heat is not used, or in the dark-room itself, but *if heat be used they must lie horizontally.*

Manufacturers generally coat very large plates, and cut them down to the required sizes with the diamond, after drying.

In summer, when setting takes place with more or less difficulty, it will be well to lay the plate on a level tin box containing ice.

While coating, it is of the greatest importance to *avoid froth and air-bubbles.* Therefore the emulsion is to be shaken as little as possible.

If the gelatine is thin and shows deficient setting power, Eder's addition of chrome alum and glycerine may be used (page 86). If it is very hard, and the plates consequently slow in developing, 5–10 per cent. of glycerine, without chrome alum, may be added. When chrome alum has been added, the emulsion must be used soon, for it sets very rapidly.

7. *The Drying.*—If the work-room is *well ventilated*, quite free from dust, and thoroughly dark, the plates may be allowed to dry spontaneously, the time occupied being longer or shorter, according to the

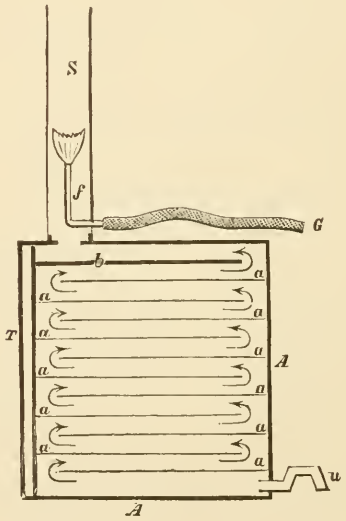
dampness of the air.[1] In damp winter weather, the drying will often occupy three days, and there is risk of those spots remaining wet the longest becoming decomposed. In such cases, efforts must be made to hasten the drying. This may be done on the small scale by immersing the (set) plate in alcohol for five minutes; this removes the greater part of the water, so that the plates will often dry in one or two hours. But this is too costly to be practised extensively. An artificial draft is generally used in such cases.

For small batches of plates the author's form of drying-box may be used (Phot. Mitth., xvi. 47). It has proved very serviceable, and may be constructed at a moderate cost. It is made of tin, and is shown in the figure in section. *T* is the door opening at two corners, and shutting light-tight, with overhanging edges; *a a* are shelves of tin soldered fast to the sides. They are so arranged that the air circulates in the direction shown by the arrows. On these shelves the plates are laid after being firmly set. The air gains access through the tube *u* under the lowest shelf, and in order to create the necessary draft, a chimney, *S*, which consists of two riveted parts fitting by a joint, and 39 inches high, is fitted at the top of the box. A gas-flame, *f*, burns inside the chimney as seen in the figure, *g* being the supply-pipe. As soon as the flame is lighted, a strong draft is formed in the chimney which sucks air through the box, and causes the plates to dry as

[1] The room must then have a double door to allow entrance and exit without the admission of light.—Tr.

quickly as they would in a well-ventilated room. If the weather is damp and it is wished to hasten the drying, a pan of fused chloride of calcium is set at the bottom of the box. It is well to arrange a piece of tin under the flame to serve as a cut-off for the light, and prevent its entering the box. The piece

FIG. 68.



b also is painted with dead-black varnish, as well as the lower surface of the upper wall of the box. Of course, the door *T* must fit tightly to the edges *a a*, otherwise the air would rise perpendicularly, and not circulate over the plates. A layer of felt is fitted to the door so as to effect this. In a box of this kind, constructed for 7 x 9 inch plates, the author dried a dozen in eight hours.

Large wooden drying-boxes have been made on

the same plan. The higher the chimney and the larger the flame the more powerful the draft. For such boxes several air-openings will be necessary, but care must be taken that the air admitted is free from dust.

The manufacturers have drying-rooms, well protected from light, and with a current of air from a ventilating machine driven by steam-power or gas.

Warm air is frequently admitted to the drying-box. The chimney *S*, for instance, may be surrounded with a metal case, and the heated air generated in the space between them conducted to the opening *u* by means of a tube; care must be taken, however, not to let the temperature rise above 76° F. We prefer dry air at ordinary temperatures. It is important that the drying proceed evenly, for at every point of the film where a check in the evaporation occurs, a streak is sure to form.

8. *Packing the Plates.*—Small batches of plates may be kept in the ordinary plate-box. It must be very tight in the joints, and painted black. Besides the lid it should have a false lid inside to protect the plates in case the former was inadvertently opened. Larger batches may be best packed between strips of cardboard in packages of half dozens. The card is to be bent zigzag, so as to pre-

vent the plates from touching when the edges are slipped in. The first and last glasses have the uncoated sides turned outwards. The package is tied, and then wrapped up in two layers of thick, dead-black paper, being finally stored in a pasteboard

box. We do not advise paper to be laid between the films, having remarked that plates so packed often spoil very soon. The plates must always be kept *in a dry place.*

(B) Eder's Method with Ammonio-nitrate of Silver.[1]

Care will be required, more particularly in the choice of gelatine, which must stand the silver-test mentioned on page 95. Attention must also be paid to the temperature to prevent fog. The author has not obtained the high sensitiveness with this process that he has with the following one, *C*, but the emulsion works so clear and intense that it is not only suitable for portraits and landscapes, but copies may be made with it, and not need intensification. (The author generally found this emulsion somewhat hard.) The apparatus for preparing it is not different from that described above.

"Dissolve 370 grains of chemically pure, dry bromide of potassium in 10½ ounces of distilled water; add from 462 to 693 grains of gelatine, and, after swelling for ¼ hour, set in a water-bath at 95°–115°, until the gelatine is dissolved. In another vessel, dissolve 462 grains of nitrate of silver in 10½ ounces of water, and add ammonia drop by drop until the precipitate formed is redissolved. Up to this point all may be done in daylight. Then, by the least possible amount of dark-red light, the silver solution is added to the gelatine, which has been

[1] Phot. Corr., 1881; Phot. Mitth., xviii. 120; Theorie u. Praxis d. Phot. m. Emuls.

allowed to cool down to 95°, the mixture being well shaken, and a few drachms of water passed around the interior of the silver flask to remove the last traces. The mixture is replaced in the water-bath at 95° (*not higher*), and left there 15–30 minutes, the heat being removed so that the water-bath may gradually cool off. The temperature may fall as low as 77° without causing the gelatine to set. Nevertheless, the bulk of the water-bath must be sufficient not to allow a fall below 77° during the digestion."

"The specific gravity of the ammonia is not of special importance. The ordinary pure, strong samples may be used. The quantity to be added is variable: as stated above, enough to redissolve the precipitate formed."

"After digestion, the emulsion is transferred to a beaker-glass with thick walls, or a porcelain bowl, and stood in cold water to set. When this has taken place, the jelly is forced through some coarse fabric (with meshes, say, from $\frac{1}{32}$ to $\frac{1}{8}$ inch square), and washed in a loose-textured bag in running water, if possible, for 24–48 hours. The individual pieces retain a good deal of water, which must be allowed to drain off for at least half an hour, either by hanging up the bag or by turning out the emulsion on a muslin cloth stretched over a large funnel. If this be neglected, the emulsion will be likely to run thin. The superfluous water may also be removed by gentle pressure."

"The finely divided emulsion can either have the water removed by alcohol, and then laid out in thin

layers to dry either partially or entirely,[1] or it may be immediately remelted in the water-bath. It may be filtered through flannel in a warming funnel, but, in the majority of cases, simple standing to deposit will suffice."

"The transformation of the comparatively insensitive variety (allowing red light to pass through it) into the very sensitive (allowing blue light to pass) takes place in a very short time if the precautions given above are observed. Even at a temperature as low as 77°, the process is generally complete in 15–20 minutes. A small amount of the emulsion may be poured out on a glass plate and examined by daylight, or a candle or gas-flame shielded by a screen, to see whether the film is blue (p. 55), in which case the digestion may be stopped. Continuing the digestion more than 30 minutes has, in general, no effect on the sensitiveness; and yet even after three hours there seems to be no tendency to fog, provided the temperature be kept down to the figure given above."

"If the solution is too hot or contains too little gelatine, or if the ammonio-nitrate of silver solution is too strong, the bromide of silver will be too coarse. In that case, it quickly settles to the bottom and separates from the emulsion. The negatives also are coarse, but there is no apparent increase in sensitiveness. This condition of the emulsion or negatives may be obtained by using, instead of $10\frac{1}{2}$

[1] Eder is not yet enabled to say that the emulsion obtained in this case would be identical with one immediately remelted; but, at all events, this preparation is more stable than the watery emulsion.

ounces of water, only $3\frac{1}{2}$ ounces for the nitrate of silver. *Negatives of this coarse, granular character might be useful for some of the permanent printing processes.*"

"Many gelatines when treated with ammonia give films having a tendency to frill away from the glass. Alum is generally of service here (Eder and Recht). Gelatine containing 5 per cent. of chrome alum will not melt again having once set, but the jelly obtained by adding as much as 10–20 per cent. by weight of ordinary alum to gelatine (or even 30 per cent.) can be remelted. The addition of glycerine favors the penetration of the developer. To correct a faulty emulsion, then, add to every $3\frac{1}{2}$ ounces from 51–102 minims of the following solution: Water, 50 parts; ordinary alum, 4; glycerine, 4. Gelatines that have become much altered require even more, but a few drops will often suffice." (Eder, Phot. m. Bromsilber Emuls.)

When this method is used, we advise that the silver be put with about one-fourth of the gelatine, reserving the other three-fourths to be added when the temperature has fallen to 77° (of course after swelling and dissolving as usual).

(C) The Author's Modification of Eder's Combination Method.

This commences by silvering with heat; boiling, and finally, treating with ammonia to obtain sensitiveness. The author has found this process excellent, although bad gelatine (see test, page 94) frequently causes loss. This emulsion is both vigorous and soft.

The effect of the ammonia was treated of on page 58. The author verified the fact that the increase of sensitiveness produced under the action of ammonia is the more decided the greater the quantity; on using double the quantity recommended by Eder, he obtained nearly double the sensitiveness. But ammonia makes the gelatine more thin (page 85), so that the author preferred to begin by mixing $\frac{1}{4}$ to $\frac{1}{5}$ of the given quantity of gelatine with the silver, adding the rest only after the ammonia had acted for the full time, and then immediately to cool the emulsion off with ice. The injurious effects of ammonia are less at low temperatures.

For reasons mentioned above, the author also replaced the bromide of potassium by bromide of ammonium. The manipulations are just the same as in Method *A*.

The boiling is only continued for half an hour, then the emulsion is cooled off to 87° by setting the vessel in cold water (the temperature being taken in the emulsion itself): then to the given quantity of emulsion, 76 minims of ammonia (sp. gr. 0.91), diluted with the same amount of water, are added, the mixture being constantly stirred; and the whole then set in water at 100°, and the temperature maintained by means of a small flame beneath. The thermometer must be constantly consulted, and nothing over 100° allowed. In this way the digestion may last 50–60 minutes. The rest of the gelatine (previously soaked, drained, dissolved, and cooled down to 87°) may then be added, and the whole immediately cooled off by ice or spring water at 55°. The emulsion will have set firmly within

two hours, and may then be forced through canvas. The first wash-water is generally very milky—a proof of the great change brought about in the gelatine by the ammonia.

This method is not so much used by practical men as the simpler one of digestion, probably on account of irregularities in the quality of the gelatine, and particularly since the silver test given on page 209 often fails in the hands of others than trained chemists.

If we compare the three methods, we will find that *A* gives the softest, most harmonious, and most sensitive plates of *moderate density*.

That *B* gives the most density but least sensitiveness, and that *C* is intermediate between them, combining sensitiveness and density, but more uncertain than *A*.

Eder consequently has endeavored to obviate the injurious effect of ammonia by substituting the carbonate for this newly published process. (See Phot. Corr., 1882, p. 154.)

(D) Eder's New Method with Carbonate of Ammonia

Is based on the use of this salt in place of caustic ammonia, and the favorable effect produced by adding $\frac{1}{10}$ to $\frac{1}{20}$ of unripe emulsion to that which is already ripe, so that brilliancy and softness are obtained (as when iodide of silver is added), and finally upon his late observation that a large quantity of gelatine does not impede the ripening, but aids it. (Page 196.)

Eder says: "In April, 1880, I published the statement that carbonate of ammonia acted in a similar manner to the caustic alkali.[1] The results of my experiments proved that it increased sensitiveness just as the caustic did, but not the density; this is an advantage for the portrait or landscape photographer. An after-digestion of the cooked emulsion with from three to ten volumes of a solution of carbonate of ammonia (1:10) at 100°–120° for ½–2 hours is very effective."

Eder also successfully tried the plan of cooking only $\frac{9}{10}$ or $\frac{19}{20}$ of a concentrated emulsion (370 grs. brom. potass. or 308 grs. brom. ammon.; 308 grs. gelatine with 7 oz. water: and 462 grs. nit. silver in 4½ oz. water) and reserving the other $\frac{1}{10}$ or $\frac{1}{20}$. After cooking the greater portion from ¼ to 1½ hours or even longer, it was quickly cooled down to 105°–120° and the reserved $\frac{1}{10}$ or $\frac{1}{20}$ of unripened emulsion added. It was then further digested with 255–340 minims of a solution of carbonate of ammonia, 1:10, at 105°–120° for half an hour, and finally the whole mixed with the gelatine solution proper (308 grs. gelatine, 10½ oz. water). If still softer results are desired, the reserved unripened emulsion is to be added after the digestion with carb. ammonia. An emulsion cooked for half an hour and then digested with carb. ammonia proved nearly twice as sensitive, when tested by Vogel's sensitometer, as one merely cooked.

Caustic ammonia, if used instead of the carbonate,

[1] Sitzungsberichte der Wiener Akademie der Wissenschaften, 1880, Bd. 81. Also, Phot. Corr., 1880, p. 143. Forrest's communication of the same fact appeared later. (Year-book, 1880.)

increases density. Instead of 1 volume of the latter, $\frac{1}{4}$ volume of the former (sp. gr. = 0.91) may be taken.

In the foregoing methods we have preferred to give those tried by ourselves with success, the number which have been proposed being well-nigh countless. Nor would it be advisable to give further descriptions of them, inasmuch as they are only modifications of the preceding (silvering with heat, cooking, and treatment with ammonia). Few manufacturers still adhere to the digestion method, which occupies several days, rather than cooking. We will now give a method, interesting indeed, *but not yet sufficiently practical* as we believe, for the preparation of highly sensitive bromide of silver by precipitation, which may afterwards be mixed with gelatine. It may be called the *precipitation method.*

(E) Precipitation Methods.

These methods aim at doing away with the injurious effects of impure gelatine (often seen during emulsification) by precipitating the bromide of silver and afterwards incorporating it with fresh gelatine.

Abney's Process consists in the precipitation of bromide of silver from aqueous solutions in presence of excess of nitrate of silver, and the incorporation of the washed precipitate in gelatine. The emulsion so made is very uniform, but somewhat insensitive (Szekely).

For 7700 grains of emulsion, weigh out 108 grains of bromide of ammonium and dissolve in 7700 grains of water, adding 96 grains of nitric acid; 179 grains

of nitrate of silver are required to convert the bromide. Abney directs that an excess, *i. e.*, 200 grains, be dissolved in 7700 grains of water, that the bromide be gradually added to the silver, keeping the mixture well stirred, and finally the whole allowed to subside. The supernatant fluid is then decanted off and the precipitate washed six or seven times in water (in the dark-room of course) until blue litmus-paper shows no acid and all traces of free nitrate of silver have disappeared.[1] Three hundred and eight grains of gelatine are then put into a flask with 6930 grains of water, and allowed to swell. It is dissolved at a medium temperature in a water-bath. The precipitated bromide of silver having been closely drained, is transferred to the gelatine by a suitable spatula and the vessel rinsed out with the hot gelatine, so that there is no waste. Vigorous shaking then gives a mixture unpromising enough in appearance; particles of bromide of silver floating about and in a much coarser state of division than is admissible in an emulsion. The vessel is now immersed in water at 90° and after fifteen minutes, taken out and shaken. If a little now be poured on a glass plate, a perfectly even and rather thin film will be obtained. The vessel is replaced in the warm water and allowed to digest for several days. Abney

[1] Abney, of late, has used glycerine in the silver solution. He recommends as follows: Dissolve 215 grains of bromide of ammonium in 33½ oz. of water; this is added with constant shaking to the following silver solution—385 grs. nit. silver, 10 ounces of water, 554 grs. glycerine, (the silver is not to be added to the bromide in reverse order). The precipitated bromide of silver is washed as above and incorporated with 308 grs. of gelatine in 8½ oz. of water. (Phot. with Emulsions, ii. p. 175.)

says "if a plate be prepared and exposed every day, the observation already made that gelatine emulsions grow more sensitive day by day will be fully verified. After the first 24 hours the sensitiveness is about equal to wet collodion and the density quite sufficient.

In this way the troublesome operation of washing the emulsion is avoided, and it becomes possible to prepare a gelatine emulsion free from salts in a couple of hours which may soon be used, for if the temperature be raised to 150°, Abney declares that the ripening may be much accelerated.

On the other hand, Szekely maintains that the sensitiveness of such an emulsion is not increased by heating for days, but remains the same. (Phot. Corr., 1882, 29.)

This process in the author's hands gave a somewhat foggy emulsion. Heating at 180° increased the fog, but not the sensitiveness. The bromide of silver was of the blue-sensitive variety (page 56).

Lohse's Process resembles Abney's, but has this great difference, that the bromide of silver is precipitated from gelatine solutions in presence of excess of soluble bromide and afterwards converted into the highly sensitive variety by heating.[1] It is not washed until this stage has been reached. This process promises better than Abney's, but a drawback to it is that the finely divided bromide of silver gradually settles. Lohse directs that chemically pure bromide of potassium be dissolved in the necessary quantity of water with the addition of about

[1] The author reduced the quantity of gelatine while silvering and cooking to one-half per cent., and yet obtained an emulsion as sensitive as when made in the above manner.

one-eighth of the total weight of gelatine required, and after swelling dissolved at a gentle heat. The nitrate of silver is then added (in the dark-room) undissolved,[1] the mixture cooked half an hour, and enough acetic acid added to the warm mixture to make the gelatine entirely fluid. After a short time the mass is poured out into a large quantity of distilled water, transferred to a cylindrical glass vessel and allowed to stand for several days. The suspended bromide of silver is so fine that it will pass through any paper filter, but after a few days, it will have settled to such a degree in the tall vessel, that the supernatant water containing the free salts, acetic acid, and gelatine may be decanted off. The pap-like residuum is treated with a little ammonia to neutralize any traces of acetic acid, and then mixed with gelatine and thoroughly shaken, after which the emulsion is ready.

Plener's Process.—Plener has lately proposed a new method of separating bromide of silver from gelatine solutions in which it has been formed.[2]

A perfectly circular, flat-bottomed metallic flask, narrowing towards the neck, contains the emulsion, and is made to revolve on a vertical axis with great speed. Under these circumstances the emulsion is driven with force to the periphery, particularly the insoluble parts, which being the heavier ones, form a compact mass on its walls, which may be rinsed with water or other liquid, and again separated from the washing fluids by centrifugal force.

[1] We prefer to dissolve the silver.

[2] Phot. News (Phot. Mitth., xix. 59).

This centrifugal force plays an important part in various branches of industry, being mostly used in the manner above indicated, the cylindrical wall of the rotating vessel generally being a fine sieve, or perforated with holes like a colander. In this way the last particles of crystallizable sugar are removed from the syrup, the latter being forced through the sieve and the sugar remaining. The centrifugal machine is also used for the drying of various chemicals, and it is also applied in dyeing, textile industries, and the manufacture of crown-glass.

In Plener's process the speed of revolution must be very great; this presupposes that the whole apparatus is solidly and accurately made, and that the rotating vessel is perfectly circular and well centred with the axis, otherwise the whole might fly to pieces. The great advantage in this process of Plener's is that an emulsion otherwise spoiled need not be thrown away as long as the bromide of silver contained in it is still good. Failures with emulsions are generally to be ascribed to the gelatine, if the preparation was carefully attended to, the gelatine either being spoiled during the process, or having been bad at the beginning. The above, therefore, is a simple plan for removing the bromide of silver, and reëmulsifying it in new gelatine. Bromide of silver thus prepared might be introduced as a commercial article, so that amateurs would find their labors in emulsion-making considerably lightened.

Mr. Plener describes the process as follows (probably a patent description): "I take any sensitive emulsion; the vehicle may be gelatine, gum, collo-

dion, or any mixture of these substances. The sensitive salt may be the chloride, iodide, or bromide of silver, or any other sensitive body. If the emulsion is solid, I first melt it with heat, and then pour it into a metallic vessel having the form of a blunt cone standing on its base; other forms might also be used. The vessel must be well silvered inside. The same is made to revolve on its vertical axis with great speed, at not less than 4000 revolutions per minute when one foot in diameter. If smaller than this it must make more revolutions in proportion; if larger, fewer will suffice. The vessel is kept warm during its rotation by means of a gas-jet or other flame, so as to keep the emulsion from setting. Thus the heavy silver salts are driven to the extreme parts of the vessel and become adherent to its walls, entire separation of the solid and liquid portions occurring in about ten minutes. The time will vary however, according to the condition of the gelatine, and the fineness of the bromide of silver. I gradually cease the revolutions, and withdraw the liquid portions with a siphon, pour warm water into the vessel, mix it up with the bromide of silver with a brush, start the revolutions again, and continue this operation until every trace of gelatine and soluble salts is removed. The bromide (or other salt) of silver thus purified may be used again in emulsion by mixing it with the proper vehicle—gelatine or collodion. When collodion emulsion is to be prepared, I mix the salt with half its weight of glycerine, and then with a liberal quantity of alcohol; allow it to settle; decant off the liquid; repeat the operation with a fresh quantity of alcohol, and

finally incorporate the powder thus obtained, after drying, with plain collodion.

"If an emulsion fogs from having been cooked or digested too long a time, I pour it into the metallic vessel and let it revolve for fifteen minutes at a rather less speed, say 2000 to 3000 revolutions per minute. Under these circumstances only the coarser particles of the silver salt separate, these being the cause of the fog. When the machine is again at rest, I remove the emulsion with a siphon, and treat in the manner above described.

"If the washed emulsion is not sensitive enough, either from error in preparation, or from the effect of any of the oxidizing substances known in photography as fog-restrainers, I add to every 25 drachms of the emulsion 15 grains of bromide of ammonium, and digest or cook in the usual way until the desired sensitiveness is attained, then I treat the emulsion as described above."

Fabre's Process.—Fabre publishes a process which belongs here also, and which obviates the washing wholly or partially. Fabre claims that chloride, iodide, and bromide of silver combine with sulphate of potash or ammonium if they are triturated together. The composition of these salts is chloride of silver, sulphate of potash ($K_2SO_4+AgCl+2H_2O$), and water.

An excess of water decomposes these double salts again, separating the bromide of silver as the greenish-yellow granular variety, which is identical with that precipitated from ammoniacal solutions by acids.[1]

[1] The color is no proof that the bromide of silver, as existing in gelatine emulsion is thus formed (blue-sensitive).

Fabre triturates 1 part of bromide of silver with $2\frac{1}{2}$ parts of sulphate of potash and a few drops of water. After combination has taken place the mixture crystallizes in needles. He then treats it with an excess of water, and washes three times to remove the sulphate of potash (not more (?) Vogel). The washed bromide of silver is mixed with gelatine solution in the proportion of 77 grains of bromide of silver, 46–77 grains of gelatine, and $3\frac{1}{2}$ ounces of water.

Van Monckhoven's published method of emulsification which dispenses with washing by adding hydrobromic acid to gelatine, and afterward mixing with carbonate of silver, has not succeeded in other hands than his own.

(F) Vogel's Emulsion.

The basis of the author's emulsion (see page 191) is a combination of collodion and gelatine. We subjoin the full patent description of the same.

"The aqueous gelatino-bromide emulsion has the drawbacks of quickly decomposing, of drying very slowly when spread on glass, of being difficult to intensify and wash, and of easily peeling away from the glass."

"I have endeavored to get rid of these evils by combining gelatino-bromide (chloride or iodide) with pyroxyline."

"Ordinary gelatine emulsion and ordinary collodion (solution of pyroxyline) cannot be made to mix in a homogeneous manner. If this be attempted, the matters dissolved will separate from

the mixture. I have succeeded in uniting both materials in the same liquid by choosing solvents both of gelatine and pyroxyline."

"Such solvents are the different organic acids, particularly the lower members of the group of fatty acids, formic, acetic, propionic, etc., and their derivatives, or mixtures of them with each other and with alcohols, particularly the alcohols of the methyl series (methylated alcohol, ethyl-alcohol, etc.)."

"I found that gelatino-bromide of silver (chloride or iodide) easily dissolves in these menstrua without precipitation of the incorporated silver salts; and further, that these salts are not influenced in their photographic action by the presence of the acids mentioned—a fact which is contrary to the opinions hitherto held. Finally, that the gelatine emulsion in such a solution undergoes a favorable modification in its characteristics (not showing the beforementioned evils of the aqueous emulsion), being improved by the combination with pyroxyline."

"I have settled upon the following practical method of producing the above combination:

"I prepare a gelatino-bromide (chloride or iodide, or mixtures of the same) emulsion according to the well-known methods now in use. This emulsion is dried either spontaneously under the desiccator, or by means of alcohol, as known. I dissolve the dried mass in from 3 to 10 times (or more) its volume of formic, acetic, or other analogous acid. The quantity of acid varies for different gelatines: less being required for the easily soluble samples, and more for those not so. This must be determined for each sample."

"The so-obtained acid emulsion is now either used alone, after being thinned down to the required consistency with alcohol or other similar material, or better, treated with pyroxyline. *This gives the emulsion keeping qualities and the power of resisting even hot water.* Pyroxyline dissolves in acetic acid or its homologues (or in mixtures of the same), and alcohol. The quantity of pyroxyline will depend upon the consistency required. At least one per cent. of the acid emulsion will be necessary."

"Instead of the foregoing, the following may be adopted: The pyroxyline is dissolved by itself in the said acid or acids (or mixtures), or with alcohols. When the pyroxyline is freely soluble, methylated alcohol (or a mixture of this with other alcohols) will sometimes dissolve it; for the less soluble samples the addition of acid is necessary. There is great latitude in the amounts to be used. As an example, I will give the following formula: Dissolve 31 grains of pyroxyline in a mixture of 770 grains each of alcohol and acetic acid."

"Suitable solutions of pyroxyline having been prepared, are now mixed in about equal volumes with the acid emulsion spoken of above. If very creamy films are desired, more of the latter is taken; if otherwise, less."

"This collodio-gelatine emulsion when gently warmed may be used like ordinary collodion emulsion. The following method may also be used:[1]

"3. Collodion emulsion is made by some approved

[1] Violet-sensitive bromide of silver (page 56) is thus formed, and its sensitiveness may be made about one-quarter that of a wet plate, but not more.

formula, precipitated with water in the ordinary manner (or it may be dried and then washed), dried, and dissolved in the acids (or mixtures), or with alcohols. To this, gelatine is added, either directly or after solution in the solvents already mentioned. For example: Dissolve 108 grains of collodion-emulsion pellicle in 2,310 grains of alcohol mixed with 1,386 grains of acetic acid, and add 31 grains of gelatine dissolved in 308 grains of acetic acid. The quantities of the mixtures to be taken admit of as much variation as the formulæ for emulsions hitherto known. Finally, I obtained a similar preparation in this way:

"4. Dissolve gelatine and pyroxyline in one of the solvents named (each may be dissolved separately and the solutions afterwards mixed). To this solution, finely divided bromide of silver (or other silver haloid salt), prepared according to known methods, is added; or this may be formed in the solution according to the method well known in the collodion-emulsion process. The said silver salts are then diffused in the liquid, forming a homogeneous emulsion. In respect to the quantities to be used, the aforesaid applies."

As a further example of the practical preparation of an emulsion by Vogel's process, we give the following notes by Von Schlicht. (Phot. Mitth., xvii. 151.)

Gelatine emulsion is made as follows: 16 grains of white German gelatine, 16 grains of dry bromide of ammonium, dissolved in 308 grains of distilled water; 26 grains of nitrate of silver dissolved in 154 grains of distilled water; 23 grains of ammonia,

sp. gr. 0.963. (For details as to silvering and treatment with ammonia, see page 218.)

The emulsion thus obtained is treated several times with alcohol after setting and washing, and finally drained closely. (Phot. Mitth., xv. 243.) If double the quantity mentioned is made, the weight, after draining off the alcohol, will be about 215–231 grains. This quantity is now to be treated with 238 minims of glacial acetic acid, and, after the lapse of an hour, dissolved in a water-bath at 95°–100° F., which occupies about 5 minutes. Four hundred and seventy-six minims of a mixture of $\frac{1}{4}$ of a volume of glacial acetic acid with $\frac{3}{4}$ vols. of plain collodion containing 4 per cent. of soluble cotton is now to be added, a little at a time, with constant shaking (the cork being eased from time to time to allow the vapors of alcohol and ether to pass off), the bottle being constantly replaced in the warm water. The mixture is now thinned with 136–170 minims of a mixture of $\frac{1}{4}$ vol. of glacial acetic acid with $\frac{3}{4}$ vols. of absolute alcohol, and finally filtered through a double fold of muslin into another yellow bottle enclosed in a pasteboard box, where the now finished emulsion may be preserved any length of time. We may add that Vogel's emulsion sets at temperatures under 76°, and may be remelted by applying heat.

B.—THE MANIPULATIONS OF THE GELATINE PLATE.

Precautions.—The gelatino-bromide plate, like all other modern emulsion plates, differs from wet collodion not only in the respects mentioned on page 191, but also in requiring a peculiar development,

intensification, and washing. While wet plates have the *physical* development (*i. e.*, a deposit of metallic silver precipitated on the exposed portions), the emulsion plate has the chemical development (reduction of the exposed portions). The high sensitiveness of the gelatine plate is manifested only under *chemical* development (page 72). The developer for wet collodion is seldom varied; at most, the quantity of alcohol is sometimes increased so as to make it amalgamate better with the film. But with the gelatine plate it often becomes necessary to modify the developer considerably so as to suit the differences in plates, quality of light, and length of exposure. This also confers the power of forcing very different results from two plates identical in preparation and exposure, *i. e.*, the negative may be made soft or brilliant, intense or thin, etc. For the intelligent operator this is an advantage, but for the man who thoughtlessly follows the same plan without variation it is a hindrance.

It must also be remarked that a tough, spongy body, like gelatine, does not allow the chemicals applied to penetrate its substance rapidly, but, when this has once been effected, the film will be found to retain the chemicals with a tenacity unknown in the collodion process.

Thus the intensification, so easily and quickly done on wet collodion plates, is attended with some difficulties on gelatine, particularly when there is any secondary influence of the chemicals used (such as tanning, etc.); the washing, also, is far more tedious. Then it must not be forgotten that gela-

tine dissolves in lukewarm water, so that the wash-waters must always be as cold as possible.

The great sensitiveness also necessitates perfectly light-tight holders, cameras, etc., and very moderate illumination of the dark-room with red light.

A. The Exposure.—The precautions in regard to shielding the lens from false lights are here even more necessary than with wet collodion. (Lehrbuch, p. 303.) Slower working lenses may be used owing to the great sensitiveness, which would otherwise rarely be tested on portraits, and their excellent qualities of great depth of focus and large field be lost to the photographer. Such lenses are the Aplanatic, Euryscope, etc. In the open air, a fraction of a second will often be enough if a portrait lens be employed and the weather favorable; indeed, the operator will sometimes be driven to use the instantaneous shutter (page 173); even the Aplanatic may be worked in the open air in less than a second. As a general rule, extra-sensitive gelatine plates receive about one-fourth of the exposure necessary for wet collodion.

B. The Development.—It has already been stated that entirely different results can be obtained from plates exposed under similar circumstances if the developer be modified. The process of development requires, on the one hand, *a strong reducing agent* (either pyrogallic acid with an alkali, or ferrous oxalate in an excess of oxalate of potash), and, on the other, a *restrainer* (generally bromide of potassium), to prevent reduction of the unexposed parts. With stronger reducers the plates develop quickly, but remain thin and weak, with great danger of fog.

With a less amount of reducer the plates develop slowly, and the lights become very dense. Decreasing the reducer corresponds in effect to the increase of bromide. With slow working plates and the ferrous-oxalate developer, the bromide may often be omitted.[1]

The surprising difference which developers of different compositions are capable of producing on the same plate is shown as follows: Two plates coated with the same emulsion received the same exposure. One was developed with 17 drachms of oxalate of potash solution, 1 : 3, mixed with 340 minims of sulphate of iron solution, 1 : 3. A thin, gray image quickly appeared, and the plate fogged somewhat. The other plate was developed with the same quantity of oxalate with only 170 minims of iron and 34 minims of solution of bromide of potassium, 1 : 10. In this case the image appeared slowly, and gradually assumed such strength that intensification was not required, the slow development permitting those parts of the image first appearing to gain density before the detail in the deep shadows came out (page 71).

The length of exposure here plays a most important part. If too long, the image flashes out when the above developer is applied (60 parts of oxalate of potash to 20 of iron), remaining gray and monotonous, and often fogging; if too short, the opposite occurs. It is always desirable to secure a dense

[1] According to Spiller and Young, brom. potass. has only three-fifths the restraining power of brom. ammonium. This applies only to the pyro-developer, the difference with ferrous oxalate being inappreciable.

negative by the developer alone, if possible, so as to obviate the necessity of intensifying. The developer, therefore, is to be modified to suit individual cases.

(1) *The Ferrous-oxalate Developer.* — This is now the favorite in Germany, giving more strength than pyrogallic acid, a blacker color to the image, and is inodorous. It also keeps longer if both solutions (iron and oxalate) are kept separate. When mixed, it very quickly absorbs oxygen from the air, so that it is well to use a fresh portion for each plate.[1] Fog is not so likely to occur with it as with pyrogallic acid. The restrainer (brom. potass.) is therefore not always required.

This developer does not admit of the same degree of concentration as the pyro-developer on account of the sparing solubility of oxalate of iron (page 27). A developer that has been used may be worked over with a little trouble and used again. It also may have its developing power much increased by the addition of a very minute amount of hyposulphite of soda (Abney).

The best working form of this developer is (Eder) to make up a stock solution of sulphate of iron, 1 : 3,[2] and one of *neutral* oxalate of potash, 1 : 3.

[1] Schaarwächter has lately advised that *mixed* ferrous-oxalate developers may be kept in stock in large quantities, in a suitable vessel, under poppy oil. He has proved that it may be kept this way for seven weeks unchanged and without access of air. The plates must be soaked for five minutes in water before dipping them into the developer, so that they may pass through the layer of oil without attracting drops to the surface of the film, which would make white spots. (Phot. Mitth., xix. 72.)

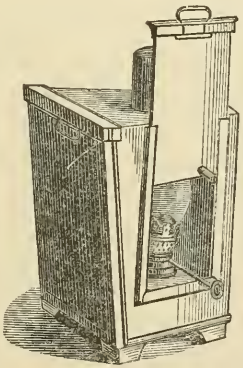
[2] Eder recommends the addition of 4 drops of sulphuric acid to every 7 ounces of solution, to prevent the separation of basic salts.

(We ourselves prefer a slightly acid sample of oxalate.) Solutions of bromide of potassium, 1 : 10, and hyposulphite of soda, 1 : 200, are also to be kept ready. Immediately before development, one measure of the iron solution is added to three measures of the oxalate (not the reverse), and the whole poured over the plate previously laid in a tray. These trays may be made of porcelain, japanned cardboard, or zinc.

If more of the iron be added, a deposit of oxalate of iron will be thrown down on the film.

The development is conducted by red light, and the following-described lantern, as made by Beyrich

Fig. 69.



and Schippang, in Berlin, is now the favorite form in that city: It burns coal-oil, and carries one or more red glasses, according to the illumination desired. Travellers will find the form mentioned on page 200 very convenient. It is further to be remarked that the energy of the developer is increased

at high temperatures; therefore, it must be used weaker in summer than in winter, and contain less iron and more bromide to control excessive action.

When it is known (from previous trials) that the plate has received *the proper exposure*, the developer is mixed in the above-mentioned proportions (for a 5 by 8 inch plate, 17 drachms of oxalate solution, 340 minims of iron), and flowed to and fro over the plate. The highest lights will appear in about 20 seconds, and continue to gain in density until the end of development, when the feebly lighted details begin to appear. If the gelatine is hard, the plates will develop slowly, and some time will elapse before the shadows come out. If the plate shows a tendency to fog, bromide of potassium solution (8 minims to every 22 drachms of developer, or even 51 minims in extreme cases) is to be added as required. In our own practice, the dish containing the plate and developer is set near the lamp, whose direct light is prevented from falling upon it by a movable screen; this is taken away from time to time, and the progress of the development examined by the full quantity of red light given by the lamp. If the detail in the shadows does not appear after lengthy development, ten drops of the hyposulphite solution (1 : 200) may possibly help matters. The developer must be poured off into a glass, the hypo added, and, after stirring, reapplied to the film. Many plates will bear as much as 30 drops of the hypo-solution, while others will fog, and demand the addition of bromide of potassium. *We advise that those plates only be treated with hyposulphite of soda which are known to be under-timed, and that the hypo be*

added only after the image has begun to develop; otherwise weak, flat results will be obtained.

For plates where over-exposure is suspected (generally landscapes), we use to every 17 drachms of oxalate only 85 minims of the iron solution and 8 minims of bromide. If the high-lights appear before 20 seconds have expired, we tilt up the tray so as to collect the fluid into one corner, and then drop in 17 minims of bromide solution; but, if the lights do not appear until after the time mentioned, the proportion of iron is kept the same throughout the development unless the details are very slow in coming up, when 85–255 minims of iron solution may be added.

For plates under-exposed, even when treated with the above developer, Eder recommends the following concentrated form: 770–924 grains of oxalate of potash are dissolved in $3\frac{1}{2}$ ounces of hot water, and 262–308 grains sulphate of iron added. This is bottled off in quantities of say 2 ounces, and if well corked will keep for some time. It is used on under-timed plates (with addition of bromide) after the ordinary developer has proved ineffectual. But it will generally be found that under-timed plates ill repay the trouble spent upon them.

Pizzighelli develops *line copies* with weak ferrous-oxalate developer (1 volume of the above mixture with one volume of water), containing more bromide (one or two per cent.).

Fixing and intensification are treated of further on.

Working over the Ferrous-oxalate Developer.[1]—After being used, it is collected in a stone crock and

[1] Too much cannot be said in favor of this cheap, easy, and effective method (Tr.)

warmed until the precipitate of potassio-ferric oxalate is redissolved. It is then treated with a solution of caustic potash until a small portion filtered off gives no further precipitate with caustic potash; it is then allowed to cool, filtered, and made slightly acid with oxalic acid. In this way a solution of oxalate of potash is obtained, which must have sufficient of the fresh salt added to make the saturated solution used in developing (Eder). The bromide of potassium (if present) remains in the solution unchanged. Nitrate of silver solution added, a few drops at a time, will precipitate it (Eder).

Dr. Lagrange has recommended pulverized iron for restoring the ferrous-oxalate developer. 231 grains oxalic acid, 231 grains bicarbonate of potash, and 77 grains finely divided metallic iron are added to 7,700 grains of developer.

2. *The Pyrogallic-acid Developer.*—This consists essentially of a solution of the acid with ammonia; it always requires the addition of bromide of potassium to prevent fog. The varying strength of ammonia, caused by escape of its vapor, renders this developer somewhat uncertain. *Hyposulphite of soda when added has no effect.* The greater the quantity of ammonia taken, the quicker the development and the weaker the picture; the greater the bromide, the slower the development and the denser the result. Sugar and glycerine slow the development and increase density, the latter not generally being as great as when ferrous-oxalate is used. Plates developed with pyrogallic acid very commonly show a yellowish stain, removable by immersion in dilute hydrochloric acid (1 : 100), and thorough washing.

A. The Plain Pyro-developer (after Obernetter). The following solutions are kept in stock:

Bromide of Potassium,	1 part.
Water,	10 parts.
Pyrogallic Acid,	1 part.
Alcohol,	10 parts.

To develop the plates, they are laid in a glass or porcelain tray, and the following poured over them without a previous wetting:

Bromide Solution,	34–85 minims.
Pyro "	68–85 "
Water,	8 ounces 6 drachms.
Ammonia,	10–20 drops.

The developer is to be mixed shortly before use in the order given. After half a minute the picture, with all its details, should appear; if it comes quicker, the same quantity of bromide solution used at first is to be added. If nothing is visible after a minute, 5–10 drops of ammonia may be added, not pouring it over the face of the plate, but collecting the developer into a corner of the dish and dropping it in there.

After a little experience, errors in exposure may be corrected to a certain degree, denser or softer results being obtainable at will. The developer is allowed to act until the desired intensity is obtained.

Berkeley recommends an aqueous pyro-solution containing sulphite of soda, in place of the alcoholic form. Dissolve 308 grains sulphite of soda in 740 grains water, and neutralize with 6 grains of citric acid; then add 77 grains pyrogallic acid. A solu-

tion is thus obtained that may be used in place of a 10 per cent. alcoholic pyro-solution, and will keep for months.

Pizzighelli and Hübl, in Vienna, have tried this addition of sulphite of soda (not hyposulphite) to the alkaline pyro-developer, and found that it keeps clear for a long time, and that the color of the developed negatives is less yellowish and more closely resembles that of the wet collodion plate.

B. Edward's Glycerine Developer:

1.

Pyrogallic Acid (dry),	1 part by weight.
Glycerine,	1 " "
Alcohol,	6 " "

2.

Ammonia (sp. gr.[1] 0.88),	8 parts.
Bromide of Potassium,	1 part.
Glycerine,	8 parts.
Water,	50 parts.

Mix 35 minims of No. 1 with 17–35 minims of No. 2, adding 17 drachms of water. The image appears quickly, and if proper exposure has been given, will generally be fully developed in a minute. For over-exposed plates less ammonia (often $\frac{1}{4}$ to $\frac{1}{2}$) is taken; for under-exposed ones, more.

C. Nelson's Sugar Developer (used very successfully by the author), works quickly, giving soft, clean results, and is excellent for portraiture. Prepare as follows:

[1] Of ammonia sp. gr. 0.90, there will be required 10 parts.
" " " 0.91, " " 12 "
" " " 0.92, " " 13 "

I.

Pyrogallic Acid,	308 grains.
Alcohol,	5 ounces.
White Sugar,	462 grains.
Previously dissolved in	
Water,	17 drachms.

II.

Strong Ammonia (sp. gr. 0.910),	17 drachms.
Water,	11 "
Bromide of Ammonium,	231 grains.
Sugar,	231 "

Both solutions will keep. To develop a 5 by 8 plate, mix together $3\frac{1}{2}$ ounces of water, 68 minims No. I., and 17–35 minims No. II., and pour over the plate laid in a tray (by red light). If the image comes very slowly (under-timing), add more of solution II. If the plate fogs, or is over-timed, add a few drops of bromide of ammonium, 1 : 10.

If more density be desired, the prescribed quantity of No. II. is not to be added at once, but *by degrees during the development.* In this case the image appears more slowly, but has greater strength. After development the plate is rinsed off and laid for one minute in a solution of alum, 1 : 12, again washed and fixed.

A solution of oxalic acid may be used for testing the ammonia solution No. II. as to its strength. Weigh out 6 grammes ($92\frac{2}{5}$ grains) of c. p. crystallized oxalic acid, put it in a measure and dissolve by pouring on 10 drachms 50 minims of warm distilled water. Afterwards dilute to 25 drachms 30 minims with water. This liquid must be kept in a well-corked bottle.

Seventeen minims of the solution to be tested are

measured out in a minim measure, and 93 minims of the oxalic acid solution added: a piece of red litmus-paper is also thrown in and the whole well agitated. If the paper remains red, the developer is too weak, in which case ammonia is cautiously added until the blue color is restored. In measuring solutions, especially when testing, care must always be taken that the measuring glass is held level, and that the *lowest part of the concave surface of the liquid is taken as the indicator.*

The quantity of ammonia added to 17 minims of the No. II. solution is thus fixed, and any necessary addition made *pro rata* when developing. A normal Nelson developer requires 93 minims of the given oxalic acid solution to become neutralized. Weaker developers that take only 76 minims of the acid solution may still be used sometimes for gelatine plates, but not for Vogel's emulsion. Stronger developers requiring 102 minims of acid for neutralization can be used without danger of fogging, *if the heat of the weather be not too great.*

C—THE FIXING.

After development is concluded the plates are washed for two minutes under the tap, immersed in an alum bath, 1 : 10, for about three minutes, washed again for two minutes, and finally laid in a solution of hyposulphite of soda, 1 : 5 or 1 : 8. Weaker fixing-baths may be used if there is a tendency to frilling or pitting (puckering of the film, or local repulsions of the developer). The fixing will often take a long time (we have seen a plate require half an hour), as well as the final washing, which should be carried out under the tap for at least half an hour.

D—INTENSIFICATION.

We have already mentioned the fact that the intensifying of a gelatine plate is not so easy as that of a wet collodion plate; a *silver intensifier* applied in the ordinary way works slowly, and is very liable to cause *red fog*. The quicker working mercury intensifiers have been much resorted to in spite of their giving results that cannot claim to be permanent. Immense numbers of formulæ for these have been proposed. Intensifying is always done after fixing, and in order to succeed, a very thorough washing after the fixing is absolutely necessary, save in the case of Edwards' modification, which is perhaps the only exception. The best gelatine plates are those requiring no after-intensification.

1. *Edwards' Intensifier:*

Bichloride of Mercury, ...	60 grains.
Water, ...	4 ounces.
Iodide of Potassium, ...	90 grains.
Water, ...	2 ounces.

Mix. A red precipitate is thus formed, which is redissolved by adding

Hyposulphite of Soda, ...	120 grains.
Water, ...	2 ounces.

This makes the liquid quite clear again.

The mixture may either be poured over the plate or used in a pan; its effect is quickly produced. If more hypo be added, it works somewhat slower, and gives a better color. Wash well afterwards.

For the chemical changes occurring when the

intensifier is mixed, see page 41.[1] The great advantage of this formula is that it may be used immediately after fixing without previously washing out the hyposulphite. Other intensifiers that are used after fixing do not show this advantage. It decomposes with time (more quickly when exposed to light), throwing down a precipitate, and is best when freshly prepared (page 42).

3. *The Ammonio-chloride of Mercury Intensifier.*— After thorough washing, the plate is laid in a solution of bichloride of mercury 1 : 50, until the surface

[1] As the author mentioned (Phot. Mitth., xvi. 241), this intensifier acts in a similar manner to the iodo-mercuric form (10 parts iodide of potassium solution, 1 : 10, mixed with 10 parts bichloride of mercury solution 1 : 50). The latter however works quicker giving more density.

The author intensified half of a stereo-plate with iodide of mercury, and the other half by Edwards' formula, until both appeared equally dense. The first half appeared more yellowish-green on the surface. When both halves were treated with strong hyposulphite of soda, the one where iodide of mercury had been used was the first to weaken. The other one soon did the same, and finally they both became as thin as before the intensification

This proves that combinations of sulphur and silver, or sulphur and mercury, are not formed, for neither compound is dissolved by hyposulphite of soda. The more energetic effect of the pure iodide of mercury intensifier compared to Edwards' is ascribable to the formation of argentous iodide and mercurous iodide by means of the mercuric iodide:

$$\underset{\text{Mercuric iodide.}}{2HgI_2} + \underset{\text{Silver}}{4Ag} = \underset{\text{Argentous iodide.}}{2Ag_2I} + \underset{\text{Mercurous iodide.}}{Hg_2I_2}$$

The hyposulphite of soda in Edwards' formula doubtless decomposes the argentous iodide as soon as it is formed into argentic iodide (soluble in hypo), and metallic silver: $Ag_2I = Ag + AgI$, so that only the mercurous iodide remains as the intensifying material, and which is only to be decomposed by a concentrated solution of hyposulphite of soda.

of the film is somewhat whitened: it is then washed very thoroughly and treated with dilute ammonia, 1 : 4, when it assumes a dense brown color (formation of a mercuric amide combination).

This method, in our hands, has proved excellent, especially for negatives that had been made for some time. Chardon asserts that the density obtained is often too great; we have not found it so.

Chardon's Intensifier.—The negative is laid in the above solution (1 : 50) of bichloride of mercury, very thoroughly washed, and immediately immersed in old ferrous-oxalate developer. The density increases gradually and the process may be watched and controlled, so that none of the detail is buried up. The bichloride changes a part of the image into chloride of silver, and this change is accompanied by a formation of calomel. The ferrous-oxalate develops and strengthens the image by acting on these two salts. The density is determined partly by the time the bichloride is allowed to act, and afterwards by the time allowed in the iron solution. It is advised that the plate be laid for a few moments in hyposulphite of soda, carrying the density somewhat past the proper point in order to allow for the weakening caused by the hypo.

Eder's Intensifier.—We have obtained excellent results with this recently published formula. The solutions, however, do not keep long. Intensify as usual with bichloride of mercury, wash the plate, and pour over it the following solution:

Water, ...	1000 parts.
Cyanide of Potassium, ...	5 "
Iodide of Potassium, ...	$2\frac{1}{2}$ "
Bichloride of Mercury, ...	$2\frac{1}{2}$ "

The intensification takes place in three stages: 1. The negative turns yellow, and is yet pretty soft. 2. The color becomes gradually coffee or chocolate-brown; after continued action of the intensifier, the plate appears very strong, and can be washed at any minute, by which the intensification is stopped. 3. The negative weakens again slowly without losing any details, by which any over-intensification can be modified.

If the brown color (2) cannot be obtained, *it is proof of the cyanide not having acted* (Eder). This may happen if the cyanide is impure, or if the solution has been kept too long: a few drops of a strong solution of cyanide of potassium will, in such a case, immediately start the brown color and increase of density, which is soon followed by the retrograde effect. Too much cyanide makes the image thin.

For another intensifier of this character, see page 254.

All negatives intensified with mercury change in the light, becoming generally lighter in color superficially. By transmitted light, however, the change is not so striking, so that a negative might be printed from with one-half shielded from the light, and still no difference be seen after quite a long time. But then again, time will often produce a yellowish or grayish opacity in negatives intensified with mercury, owing to unexplained decompositions which render it absolutely worthless. We hold that the silver intensifier is more reliable, even if it be slow in action and liable to cause spots.

Silver Intensifiers.

A. Abney's.—The gelatine negative is washed half an hour after fixing, laid for 5 or 10 minutes in a solution of 340 minims of peroxide of hydrogen in 14 ounces of water (this solution may be bought ready prepared), then intensified with pyro and silver, or iron. For this purpose, 85 grains of sulphate of iron and 170 grains of citric acid are dissolved in 18 ounces of water. Abney prefers this intensifier to mercury.

B. Wight's Silver Intensifier.—

I. *Iron Intensifier:* The following stock solution, which keeps very well, is prepared:

G	5	parts of	good White Gelatine dissolved in
	50	"	Glacial Acetic Acid, diluted with
	100	"	Water, and filtered.

For use, dissolve—

E	4	parts of	Sulphate of Iron in
	120	"	Water; filter, and add
	10	"	Solution G.

(This solution keeps for some time.)

S	3	parts of	Nitrate of Silver in
	100	"	Water, to which are added
	4	"	Glacial Acetic Acid.

(Also keeps well.)

After the plate has been washed thoroughly, it is placed for some minutes in a saturated solution of alum in order to prevent the risk of frilling the film, in the subsequent acid bath. After the alum, the plate is rinsed, and placed for about five minutes in a

three per cent. glacial acetic acid bath. In the mean time, pour (for a 5 by 8 plate) about 85 minims of silver solution (S) into a glass, and place that and the bottle with the solution E within easy reach. The plate is then removed from the acid bath, rinsed, and the solution E at once poured over it, taking care that the plate is well covered; if necessary, aid with the finger. Care must be taken to have an abundance of solution on the plate. The solution is now poured off the plate into the glass containing the solution S, and then at once poured back again over the plate. The intensification goes on evenly. If red patches form, it becomes necessary to rinse forthwith, and then to pour on a two per cent. solution of cyanide of potassium. But if care is taken nothing of the sort will appear.

II. *Mercury Intensifier:* This intensifier Mr. Wight uses only in case of need and for certain purposes. He strengthens first slightly with the iron-silver intensifier, although he can use it also without the latter. The formula stands as follows:

4 per cent. solution of Bichloride of Mercury and a
2 " " Cyanide of Potassium.

(Both keep a good while.)

The manipulation is quite simple—after the bichloride of mercury has acted thoroughly, and the plate has been rinsed well, the cyanide solution is poured over it. A warm brown tone appears at once, and the shades remain quite clear; when ammonia is used this is seldom the case. Also no danger of turning yellow is to be feared. Of course, thorough washing is strictly necessary.

E—THE DRYING AND FINISHING.

In moderately warm air, gelatine plates dry in from one to two hours; but when it is damp and cold, much slower. If the operator is pressed for time, the finished negative may be laid in alcohol of 80° for six minutes, with occasional agitation, and then stood up perpendicularly to dry, which will take place in an hour. Many are in the habit of printing from gelatine negatives without varnishing, but there is always risk that the film will absorb silver from the paper and show brown spots. It is better to protect the film at least with plain collodion, which is to be applied after drying, and may contain 1–1½ per cent. of cotton. The usual negative varnish may afterwards be applied. Retouching cannot be well done on the gelatine film; it is better done on the varnished surface.

2. *Vogel's Emulsion Plates.*—The advantages of this emulsion have been detailed above, and although it has not yet come into general use, it has been highly spoken of by those who have used it in hot weather and while travelling. It keeps about as long as iodized collodion, *i. e.*, six months.[1] For restoring spoiled emulsion, see below. Plates prepared with it are not more costly than commercial gelatine plates. A neat operator will consume about 85 minims of emulsion on a 5 by 8 plate, *if the drip from the corners is saved.* This is worth about six cents, while a gelatine plate of the same size is worth about double.

[1] The author is at present engaged in modifying the emulsion so that it will contain less acetic acid, and have better keeping qualities.

1. The plates must have a substratum of chrome gelatine (page 212).

2. The flowing of the emulsion is done by setting the bottle containing it in warm water at 145°–170°, until the emulsion, which sometimes sets in the cold, becomes *entirely liquid*. This occupies 10–15 minutes. It is then well shaken, allowed to settle a moment, and poured on the plate like collodion; it does not spread so easily however, and evaporates more slowly.

After the *warm* emulsion has flowed all over the plate without stopping long at any one spot (any stoppage makes a streak), it is allowed to drain off at one corner. When the greater part has flowed off, the plate is turned so that one of its lower edges (*i. e.*, where the emulsion is thickest) is made perpendicular, and a few drops allowed to drain off in this position: the plate is then again turned so that the other thick edge is perpendicular, and after a few drops have drained away, the plate is brought back to the first position again; this is repeated until the thick lower edges are firmly set. When the plate can be turned so that the lower edges do not drip nor run, setting has taken place, and it is then put vertically in a rack to dry.

Beisgen's tilting machine, which has a horizontal axis, is very convenient here. The coated plate is laid upon it, and a reverse motion made every five seconds, fresh plates being constantly flowed. By the aid of this apparatus, twice as many plates may be coated in a given time as without it. Twenty-five plates may easily be prepared in an hour. A

piece of tissue-paper is laid on the lower part of the apparatus to catch drops of the emulsion.

The emulsion that has flowed off is received in a *separate bottle. The flowing is done in the dark-room by red light.* Yellow-glass bottles with wide mouths should be used for flowing, and after finishing, the necks should be wiped out with clean paper to prevent the emulsion from drying there. In winter it is absolutely necessary that the room be well warmed.

3. *Exposure.*—For portraits, this may be one-fifth to one-quarter of a wet-collodion exposure. The plates are as sensitive as the best English gelatine plates.

4. *Development.* — For this, Nelson's developer (page 247) is very good; it works quickly, soft, very clean, and is the preferable one for portraits. The *right strength* of this developer is an important point for Vogel's emulsion (see test, page 247). After development, the plate is rinsed off in water and laid for a minute in an alum-bath, 1 : 12; again washed and fixed. The iron developer does not work so well with Vogel's emulsion. Better than this is the soda developer, whose advantages, as compared to Nelson's, are better keeping qualities and absence of smell, besides the greater variations of density producible in the negative. Its only drawback is that sometimes it seems to give rise to blisters. Dissolve 3,234 grains of soda and 8–31 grains of bromide of potassium in 12 ounces 5 drachms of water. In hot weather, more bromide will be necessary to prevent fog.

To develop, take $2\frac{1}{2}$ ounces of water, 68–85

minims of solution of pyrogallic acid in alcohol, 1 : 10, and from 425–460 minims of the above soda solution. This works well for portraits; for landscapes, particularly on overcast days, add from 8–10 minims of bromide of potassium solution, 1 : 4.

The less bromide in this soda developer, the softer the results and the quicker the development; the more, the greater the density. Thus the operator has it in his power to obtain very dense or even hard negatives (for reproductions), or soft and harmonious ones, as desirable in portraiture.

The plates after being developed are *not washed*, or blisters will form, but are laid in a solution of 300 parts of common salt, 90 parts of alum, 1,000 parts of water. After this has acted for a minute, the plates are washed and fixed as usual.

5. *The Fixing* takes place easily and quickly in a solution of hyposulphite of soda, 1 : 8. If the plates show a tendency to blister in the fixing-bath, it is proof that they were not thoroughly dried after flowing, or that there was something wrong with the substratum. Yellowish dots (black by transmitted light) will disappear by continued action of the hypo. Finally, the film is washed for the same length of time as a collodion film.

6. *Intensification* is not always necessary. The ordinary silver intensifier is the best. The *unfixed and washed* plate is flowed with weak acetic acid (1 : 100), and then intensified as usual. The silver intensifier works slowly, but very harmoniously. The *mercury intensifier* is quicker in action. Prepare as follows: (*a*) bichloride of mercury solution, 1 : 50; (*b*) iodide of potassium solution, 1 : 10; mix 170

minims of (*a*) with the same amount of (*b*) and 340 minims of water. This is applied to the plate *after fixing and thorough washing.* A thorough final washing must also be given. Edward's intensifier (page 249) may also be used.

7. *Drying and Varnishing.*—Before the film has been varnished it presents a matt surface which takes the retouching-pencil very easily. The varnish is applied just as in the case of the collodion plate. The density is slightly decreased by the varnish.

8. *The drippings from the plates* after flowing are warmed until fluid (see above), and filtered, *warm*, through a piece of muslin cut to fit a glass funnel. The muslin should be lifted with the finger from time to time, in order to assist the filtration. The drippings are just as good as the fresh emulsion; if too thick, it should be thinned down with a mixture of 1 part glacial acetic acid and 3 parts alcohol.

9. *Precautions. Water precipitates the Emulsion.*—Care must therefore be taken not to let any drops of water find their way into it, or on to the plates before flowing. The bottles for the emulsion must also be *perfectly dry.*

The rough edges of the plates must be carefully cleaned, impurities present here injure both the negative and the emulsion. The corks in the bottles easily break, so care must be taken in opening them. Streaks occasionally form during the drying of the finished negative, which will disappear on varnishing if the plate has been well washed.

If the films given by an old emulsion are granular or sandy, dissolve 15 grains of gelatine in 85 minims of hot glacial acetic acid and add it to 3½ ounces of

the emulsion (previously liquefied); shake well and pour the whole out into a beaker-glass standing in boiling water. Stir well, so as to allow, say $\frac{1}{10}$th of the alcohol (or acetic ether, which forms in old emulsions) to pass off: then filter.

3. FAILURES IN GELATINE PLATES.

A. In the Preparation of the Emulsion and Coating of the Plates.—It would be a difficult matter to prepare a list of the failures in the gelatine process. If the rules laid down in Chap. VII. are adhered to, there will be no failures to complain of. But we know from experience, that advice given is not acted upon, and that many neglect the most important rules even when underlined. Want of chemical knowledge does the rest. The chief causes of failure are enumerated below:

1. *Settling down of the Bromide of Silver* occurs if the emulsion has been too quickly mixed, and not well shaken or stirred, or if the gelatine is too thin. In this case add to every 100 parts of emulsion 2 parts of gelatine. But if the gelatine has been decomposed by too long-continued boiling or digestion this will have no effect.

2. *The Emulsion flows badly over the Plate.*—(This seldom occurs with the chrome gelatine substratum.) Help it along with a glass rod or camel's-hair brush.

3. *Air Bubbles.*—While flowing take care to avoid shaking the emulsion; if air bubles form, they may be best removed by filtering through flannel or cotton. The addition of alcohol is also recommended.

4. *Unequal thickness of the film* is most apt to occur when emulsion, having once been poured on the glass is allowed to partially run off again. The side at which the draining off occurs is almost always the thickest. We prefer even spreading on a plate laid horizontally.

5. *Streaks and Marks.*—These may occur if the emulsion or the plate becomes too cold before flowing, and if the plate dries unevenly. *The drying-box should not be opened until the plates are thoroughly dry; and irregular draughts of air must also be avoided.*

6. *The Emulsion refuses to set.*—The plate may be laid on an ice-box (page 214). If it still will not set, the emulsion probably contains too little gelatine, in which case 2 or 3 per cent. of fresh gelatine may be added. Sometimes the gelatine becomes decomposed during the cooking; here the addition of chrome alum (page 86), or ordinary alum will be useful (page 221).

7. *Fogging.*—If the emulsion fogs, the operator must convince himself that it does not proceed from stray white light, over-exposure, or unsuitable developer (containing too little bromide of potassium, or too strong). If it cannot be traced to either of these sources, the gelatine has been decomposed either in the preparation (page 193), or during the time that it has been kept. Abney recommends that such emulsions be pressed out into a solution of water 1,000 parts, bichromate of potash 6 parts, allowed to stand for four to five hours, and then washed. Tincture of iodine will sometimes prove useful; but not more than a few drops are to be

added to every 3½ ounces of emulsion, a large excess injuring the sensitiveness.

Eder recommends that foggy plates be treated with a solution of 3½ ounces of water containing 154 grains each of red prussiate of potash and bromide of potassium, followed by thorough washing. This might also be useful for foggy emulsions. In all cases this treatment will be found to somewhat decrease sensitiveness.

If the coated plates take longer than three days to dry, those spots which remain wet longest will be almost certain to decompose and fog. Such plates are useless. Haack recommends sprinkling the drying-room with carbolic acid. For fog arising from other causes, see the preceding.

8. *The plates may be expected to become mouldy if kept in a damp place.*

9. The plates show a discoloration at the edges when developed after being kept for some months. The reasons for this appear to be badly cleaned glass, decomposed emulsion, or packing the plates between sheets of paper(?).

B. In Developing, Intensifying, etc.—10. *Fog.* (*a*) The plate is *over-exposed.* In such a case the plate develops very quickly, but the image is soon filmed over.

(*b*) The plate has been exposed to light. In this event the fog appears before the image has had time to develop. Examine the camera, holders, plate boxes, etc., to see whether they are perfectly light-tight.

(*c*) The developer is too strong or contains too little bromide of potassium. Remedy: dilute the

developer, or add 17–35 minims of bromide solution (1 : 10) to every $3\frac{1}{2}$ ounces of developer.

(*d*) The emulsion is decomposed. (See No. 7, above.)

(*e*) Two or more of the reasons stated may act together. In such a case give shorter exposures, taking great care to prevent the access of white light to the film (even the red lamp may act injuriously if brought too close to the film and kept there too long a time). If this does not help matters try a weaker developer,[1] or one containing more bromide. If this still produces no effect, the emulsion is spoiled. Eder's formula, given in No. 7, may then be tried.

11. *Red Fog* is caused by an excess of silver present in the preparation of the emulsion, or if the bromized gelatine be poured into the nitrate of silver (Chardon). Abney maintains that red fog does not appear with the ferrous-oxalate developer.

12. *Yellow Fog* often occurs with the pyrogallic-acid developer. To remove it, the plate may be laid in weak hydrochloric acid (1 : 100), and well washed.

13. *Green Fog* only occurs with emulsions prepared in certain ways. It is best seen after the plate is fixed. Immersion in solution of peroxide of hydrogen[2] is recommended.

14. *White Fog* appears if the wash-water after ferrous-oxalate development is very hard (formation of oxalate of lime). The plate may be laid in weak hydrochloric acid (No. 12).

[1] With ferrous-oxalate by reducing the quantity of iron; with pyrogallic acid by reducing the ammonia.

[2] This may now be had at a very moderate price of Schering, in Berlin.

15. *Fog during Intensification* will inevitably happen if the plate be not thoroughly washed both before this process and during its different stages. It is very difficult to get rid of.

16. *Thinness of Image* may be caused by too thin a film of emulsion (if unevenly flowed, thin spots will occur), too quick action of the developer, over-exposure, or too little restrainer in the developer. The character of the emulsion itself must of course be taken into account. Many emulsions give hard, blocky results (*e. g.*, those prepared with ammonio-nitrate of silver); others, again, soft and harmonious pictures (cooked emulsions, page 246). If the pyro-developer be used, see that the ammonia is of the right strength (page 000). The slower the image appears the stronger it will be; the quicker, the reverse. Compare rules given on pages 238–239.

17. *Hard Pictures* may be caused by (*a*) under-exposure; this naturally occurring oftenest in slow-working emulsions. A stronger developer (page 243) will sometimes be of value here (*i. e.*, one containing more oxalate, more iron, and less bromide). The same is true for emulsions which from any cause work with excessive intensity. Extra-rapid plates have a tendency to become thin rather than hard. For directions how to soften crude high-lights, see page 270.

18. The greatest drawback to gelatine is the lifting, folding, and loosening of the film. If this happens at the edge of the plate, the film folds or frills; if at the middle, it pits or blisters. It seldom occurs during development; more often in the fixing-bath; and still more often in the after-washing.

It is caused by lack of adhesion of the gelatine. This may occur as the result of decomposition owing to long cooking, or too long a time occupied in the drying of the coated plate. Alum added to the emulsion (page 221), or immersion of the plate in a 3–5 per cent. solution of alum before development, followed by careful washing, or immersion in dilute alcohol after development, has been recommended. Abney proposes coating the plate with a 1 per cent. plain collodion as a radical cure for the trouble. The plates are to be laid in water until the greasy lines disappear before putting them into the developer. If the frilling takes place at the edges of the plate, an edging with India-rubber solution may be applied. The addition of alcohol to the fixing-bath in as great amount as it will bear without precipitation is also advised by the same authority. Blisters in the film should be gotten rid of as soon as perceived (if possible) by laying the plate in alcohol.

19. *Sandy Deposit in the Ferrous-oxalate Developer* occurs if it contain too little oxalate of potash. Oxalate of iron then separates in crystals. Remedy —the addition of fresh oxalate of potash.

20. *Granularity of the Negative* may come from careless mixing of the emulsion when silvering, from too long-continued digestion, or the decomposition produced by ammonia. For this there is no remedy.

21. *Yellow Spots, Black by Transmitted Light*, are nothing but undissolved patches of bromide of silver. Replace the plate in the fixing-bath.

22. Failures in intensification *after fixing* are proof of insufficient washing; the remains of the hyposulphite of soda forming precipitates with the mer-

curial compounds (Edwards' excepted).[1] The silver intensifier has a tendency to produce red fog, particularly if too little acid be used, or if there are any traces of hyposulphite in the film. Cyanide of potassium will sometimes remove this red fog, but it must be used with care. Plates brought up with silver had better be fixed a second time to prevent darkening. When mercury has been used, the negatives whiten in daylight, without however being injured for printing purposes; but if the mercury is imperfectly washed out they grow darker. In this case they can hardly be saved.

23. *The Negative turns Brown during the Printing.*— In the case of unvarnished gelatine plates this is ascribable to absorption of silver from the paper. There also the negative is probably gone past recovery. It is better to varnish before printing.

24. *The Plate fixes very slowly* if the gelatine is hard, and if the fixing-bath be either too weak or too strong.

[1] The best results with mercurial intensification are to be obtained by letting the plate dry after it has been thoroughly washed, and before applying the mercury, soaking it in a saturated solution of alum *without a previous wetting.* The alum then hardens the film and prevents frilling and at the same time eliminates any traces of hypo that may have remained in spite of the washing. It does not necessarily follow that a gelatine film is well washed merely because it is left for a long time under the tap. The action of the alum here, *before application of the mercury*, is of far more value than before fixing. The addition of citric or hydrochloric acid to the alum however, is of very doubtful value in preventing stains, and is almost certain to frill the film unless the immersion be very short, or the sample of gelatine used a particularly resistant one.—Tr.

4. NOTES ON THE GELATINE PROCESS.

Intensification of Gelatine Plates with Silver and Gallic Acid.—An article in the Phot. Correspondenz speaks highly of the following formula as giving very clear shadows and the general appearance of a wet plate. Prepare as follows:

1.

Gallic Acid,	1 part.
Alcohol,	10 parts.

2.

Nit. Silver,	1 part.
Water,	16 parts.
Acetic Acid,	$\frac{1}{4}$–$\frac{1}{3}$ part.

Both solutions keep well.

For use, mix 1 part of solution 1 with about 4 parts of distilled water, and add a few drops of solution 2. It remains clear and colorless, and does not throw down a deposit of silver. It is used after fixing, and in ordinary daylight.

Before pouring it on the plate it is absolutely necessary to wash well (to remove hypo), and swill with dilute sulphuric acid (a few drops to $3\frac{1}{2}$ ounces of water), allowing it to remain on for $\frac{1}{4}$ to $\frac{1}{2}$ minute to convert the last traces, then to wash again, and to give a final rinse with distilled water, if the wash-water be hard, so as to carry off any lime salts. This acid wash will be found to clear the plate without attacking any of the fine detail.

Gelatino-bromide Paper.—In order to coat paper with gelatine emulsion, the latter is put into a tray, kept warm by immersion in a water-bath, and plain

paper floated upon it, taking care to avoid air bubbles.

It will be found convenient to lay a glass plate over the dish, leaving a small space at one end uncovered. Fold back say half an inch of one edge of the paper before floating. When the time has expired, seize the paper by this free edge and draw it back over the glass plate, leaving it there until the emulsion has set, after which it may be pinned up to dry.

The Phot. Corr. Supply Association recommends the following developer for this paper:

(1) Chrome Alum Solution, . .	1 : 25
(2) Oxalic Acid " . .	1 : 80

A. Neutral Oxalate of Potash, .	1848 grains.
Glycerine, ...	231 "
Chrome Alum Solution (1), .	255 minims.
Oxalic Acid " (2), .	255 "
Water, ...	16 oz. 6 drachms.

For use, take 8 volumes of *A* (rather too much, Vogel), and mix with it 1 volume of sulphate of iron solution 1 : 4. To render gelatine-paper negatives transparent, Obernetter recommends vaseline. Paper may be prepared with gelatino-chloride in the same manner, and it is fair to expect that these forms of photographic material will be much used in the future. For preparation on the large scale, a machine similar to that used in pigment printing will be almost a sine qua non.

Stripping Gelatine Negatives.—If this is to be done, the glass must be collodionized before coating with emulsion. The latter does not spread easily on the

collodion surface, and must, therefore, be helped with a flat brush.

After the negative is taken it is hardened with alum, and then either a second coating of gelatine applied and dried (Lehrbuch, iii. p. 405), or the plate coated with transfer collodion (ibid.).

Plener publishes a new method of stripping: "If the gelatine negative has been collodionized and varnished, these substances must be removed with alcohol or alcohol and ether. Make a solution of 1 part of hard gelatine in 8 parts of water, and pour it on the negative, which must lie on a levelling stand; allow it to set and dry, either spontaneously or by the aid of alcohol; then lay the plate in weak sulphuric acid (1 part acid, 12 parts water) for 5 or 6 minutes, then in a mixture of 4 parts of a solution of fluoride of sodium in water (1 or 2 : 100), and 1 part of weak sulphuric acid 1 : 12."

"This mixture must be kept in an asphaltum or gutta-percha tray. The film soon loosens from the glass, and must be replaced in the dilute sulphuric acid, then laid in water, to remove the acid, and finally squeezed down to a waxed-glass plate, such as is used for the transfer in pigment printing (Lehrbuch, p. 386), the edges secured with wooden strips and spring clothes-pins, and the whole left to dry. Then the elastic blade of a penknife is passed under the edge, and the negative loosened from the glass. During the drying it is advisable to leave a pan containing ammonia near the plate, so that the fumes may neutralize any remaining traces of acid."

Reducing the Excessive Intensity of Gelatine Plates.—For this purpose Abney recommends a solution of

15 grains chloride of iron in 462 grains of water. The plate is immersed for a short time, then washed and fixed.

Prümm recommends the following very highly: 1 part sulphate of copper and 3 parts common salt dissolved in 10 parts of water. For use, dilute eight or ten times with water, immerse the plate, and watch carefully until the desired reduction has taken place, then lay it in the hypo fixing-bath, and wash thoroughly.

Cyanide of Potassium in Concentrated Solution may also be used. It may be applied locally to such parts as are too dense. It works very quickly, and is to be immediately washed off.

Consumption of Emulsion per Plate.—The cost of emulsion used on plates of any given size is determined by the amount of bromide of silver in the emulsion. Eder used one containing 69 grains of nitrate of silver to every $3\frac{1}{2}$ ounces, and consumed at the rate of 0.68 minim to every $\frac{6}{16}$th square inch of surface; *i. e.*, 3 drachms 7 minims for a plate 5 by 8 inches. Forrest consumed 1.02 minims for the same superficies, his emulsion containing 46 grains of nitrate of silver to every $3\frac{1}{2}$ ounces; *i. e.*, 4 drachms 32 minims for the 5 by 8 plate. Eighty-five minims of Vogel's emulsion is enough for a plate $7\frac{1}{4}$ by $8\frac{1}{2}$ inches.

Consumption of Silver in the Negative Process.—Eder has determined the amount of silver contained in films prepared by different methods, and gives them in the following table:[1]

[1] As the minute amounts given in the table would hardly bear reduction to English terms, the original is preserved.—Tr.

	Gelatino-Bromide. gr.	Vogel's Emulsion. gr.	Washed collodion-bath plates. gr.
Total weight of the dry sensitive film for 100 cm. superficies:			
Minimum, ...	0.150	. . .	0.022
Mean, ...	0.20 to 0.30	0.104 to 0.136	0.040 to 0.058
Maximum, ...	0.392	. . .	9.073
Quantity of metallic silver contained in the film for the same:			
Minimum, ...	0.052	. . .	. . .
Mean, ...	0.07 to 0.10	0.06 to 0.09	0.013 to 0.020
Maximum, ...	0.134	. . .	. . .
Quantity of silver in negatives developed and fixed, per 100 cm.:			
Very faint image with oxalate,[1]	0.004 to 0.007	. . .	0.0032[2] (with pyro.)
Normal result with oxalate, ...	0.012 to 0.02	. . .	. . .
Very vigorous result with oxalate, . .	0.022 to 0.028	. . .	. . .
Normal result, pyro. devel., ...	0.008 to 0.010	0.008	. . .

This proves that the bath plates contain least silver, and give thin images requiring after-intensification. The results of the analysis are not surprising here, because the quantity of silver contained in the whole film will be represented simply by those portions which form the shadows; thus the bath plates are poor in silver. A very vigorous negative

[1] The very weak image came from too short exposure or development. Those plates containing even the minimum in the sensitive film gave normal results with suitable treatment.

[2] The negative developed with alkaline pyro. remains very thin even under long-continued development, because the film is too thin. The intensification with silver which would have been required to give a good result was omitted, because the additional silver deposited would not have been allowed for in the table.

contains from four to five times as much silver as a very thin one, and about double as much as an ordinary one; but the thinnest emulsion film met with in practice contains silver enough to give a vigorous negative.

Relative Cost of the Gelatine and the Wet-collodion Processes.—According to experiments made by the author, not more than 5 drachms 40 minims of collodion are required for every square foot of plate coated. This is worth about 4½ cents. Add to this the consumption of silver-bath, including loss by filtration, spilling, etc., which will amount to not more than 256 grains per square foot. A pound of nitrate of silver being taken at 70 marks (about $17.50) would make this, say, 6 cents for a bath at the strength of 10 per cent.; so that the outlay for collodion and silver-bath (per square foot) would amount to about 10½ cents, or for the 5 by 8 inch plate not quite 3 cents. Allowing the cost of the glass at 5 cents, the value of the finished 5 by 8 plate will not be more than 8 cents, and often much lower, as many operators get along with three-quarters of the given quantity of collodion and half the amount of silver-bath, besides which the glass is sold at a reduction when large orders are given. It is beyond question that even when buying wholesale, the cost of the wet-collodion plate is less than that of the commercial dry plate. Taking the cheapest dry plate at 10 cents (5 by 8), the difference is about as 3 : 4.

Recovery of Silver from Waste Gelatine Emulsion.—Abney advises that the emulsion be made fluid with heat, slightly acidified with hydrochloric acid, and

then boiled for two or three minutes. The gelatine becomes thin, and the bromide of silver deposits. By another method of Abney's, one-tenth of the volume of the warm emulsion of caustic soda is added to it, and the whole boiled as before. By this, the bromide of silver is reduced to the metallic form and soon settles down from the fluid, when it may be incinerated (fusing is better) and dissolved in nitric acid.

Gelatine Emulsion Prepared in Daylight.—Bichromate of potash mixed with gelatine emulsion decreases its sensitiveness materially, but, if washed out, the sensitiveness returns. This is the basis of Edwards' method of emulsification, which is carried on in daylight by adding to a bromized gelatine as much bichromate of potash as there is bromide present (Eder's second process, page 218). Plates are coated with the emulsion in daylight and afterwards washed in the dark.

Table for Testing the Strength of Ammonia.—The very variable strength of ammonia, which is well known to rapidly weaken if left in badly closed vessels, has repeatedly been at the bottom of the troubles experienced by photographers with the otherwise excellent pyro-developer (page 245). It is now a matter of necessity to be able to test for the strength of this fluid.

Carefully balance a 100 c.cm. glass flask on the scales, fill it with the ammonia to be tested so that the *lowest curve* of the fluid touches the mark, and weigh the whole. The strength is then to be calculated from the weight according to the following table. This is for temperatures of 60° F.; for

higher temperatures it gives too high results, and for lower ones too low results. The figures divided by 100 give the specific gravity. The *lighter* the ammonia, the better it is:

Weight.		Strength.
89	grammes,	33 per cent.
90	"	26.5 "
91	"	23.5 "
91.3	"	22.6 "
92	"	19.5 "
92.25	"	18.6 "
93.2	"	17.2 "
94	"	14.86 "
94.5	"	13.4 "
95.17	"	12 "
95.5	"	11.125 "
96	"	9.75 "
96.5	"	8.5 "
97	"	7.07 "

For the Purification of Gelatine, Eder recommends peroxide of hydrogen. It is well adapted for breaking up the reducing matters found in many samples of gelatine.

Darkening of Gelatine Plates in Daylight.—Van Monckhoven maintains that (page 55) the ripe, highly sensitive bromide of silver of gelatine plates is more sensitive to development, but darkens more slowly in daylight than that of unripe emulsions. The author believes this to be an error. He prepared gelatine emulsion in the cold (100°), and then cooked half the batch for an hour. Both were washed for the same time, and then plates prepared. The ripe emulsion was decidedly greener than the other. Two plates of each kind were exposed simultaneously to light (in the afternoon—rainy

weather), when the ripe emulsion took a much darker color in the same time than the unripe. The color also was different: bluish-gray in the unripe, and reddish-gray in the ripe sample. When fixed, the color nearly disappeared from the former, but remained distinctly visible in the latter. Sachs' gelatine plates do not strike as dark a color, but the action is distinctly greater than in the case of unripe emulsion. The former also show the greater action in a still more marked manner after fixing.

Alcohol in Gelatine Emulsion.—Abney recommends the addition of one-eighth part of alcohol to the finished gelatine emulsion. It confers better keeping and drying qualities, and lessens the risk of blistering.

To Shorten the Tedious Washing of Gelatine Plates, Cotesworth recommends a *very weak* solution of eau de javelle (hypochlorite of soda). This has also been proposed for paper prints. Swinton uses two such solutions, in which he dips the negatives after fixing and a short washing; leaving them there ten minutes. After this, he gives another short wash, so that each plate, development included, consumes not more than $6\frac{1}{2}$ pints of water.

Preparation of Reversed Negatives or Positives.—Captain Biny communicates as follows concerning a method first proposed by Bolas (page 69).

Take a dry gelatine plate which may have been light-struck, or even exposed (but not developed), and thus rendered useless for ordinary purposes. Lay it in a 4 per cent. solution of bichromate of potash, taking it out again after ten minutes, and drying it over night in a well-ventilated drying-

closet without washing. Expose it under a negative or positive either in line or with half-tone in an ordinary printing-frame, treating it like an ordinary photographic plate, and timing the exposure by the photometer: over-exposure must be avoided. The plate is then taken into the dark-room and washed with water until all the soluble bichromate is removed. This occupies about 15 minutes. It is then laid, film side up, on a black cloth and exposed to diffused daylight for a second, after which it is brought back to the dark-room and developed with ordinary ferrous-oxalate developer. If not over-exposed, the image will come slowly and surely, negative if a negative was used, and vice versa.

The parts affected by the first exposure to light in the printing-frame do not develop, inasmuch as they have become insoluble and do not allow the developer to penetrate; but all the other parts will appear consequent upon the second exposure, where the film was not insoluble owing to removal of the bichromate by washing. The picture so obtained is reversed and suitable for the printing press. After development the plate is washed and fixed in hypo, leaving it in somewhat longer than usual for a gelatine plate, in order to allow the fixing agent to remove all bromide of silver from the insoluble portion. This goes on slowly, but without special difficulty. If blisters are observed before or after fixing, the plate is laid in an alum bath, like any other gelatine plate. It is finally well washed and dried.

If alum has not been used, the plate while wet will show the image in relief, with the prominences formed by the parts acted on by light.

By this process reversed images may be prepared without using a prism or stripping the films, in which condition the form and dimensions of the picture are liable to change. The operator has it in his power to produce copies softer or more dense and brilliant than the original at will, thus correcting possible deficiencies in the latter. A little practice soon gives the certainty desirable.

Blue-sensitive Bromide of Silver.—The author has made further experiments in the preparation of this and the violet-sensitive varieties (page 56). It seems that gelatine or collodion is not indispensably necessary to the formation of these modifications. His experiments proved that,

(1) The precipitation of bromide of silver from aqueous solutions (whether in presence of excess of silver or bromide) gives the *blue-sensitive* variety, while precipitation from alcoholic solutions the *violet-sensitive.*

(2) The blue-sensitive variety mixes with collodion with difficulty,[1] but easily with gelatine, the violet-sensitive behaving in just the opposite manner.

(3) The presence of so-called colloid bodies (gelatine in aqueous solution, pyroxyline in alcohol) does not change the behaviour of the bromide of silver to the spectrum, but merely brings about the extreme subdivision necessary in a good emulsion.

(4) Bromide of silver precipitated from an excess of bromide of potassium becomes more sensitive by

[1] For these reasons, attempts to prepare a blue-sensitive emulsion with collodion *alone* have little prospect of success. For further details, see Phot. Mitth., xix. 85.

boiling, but not that precipitated (and washed) from an excess of nitrate of silver. A large excess of bromide of potassium retards the ripening (increase of sensitiveness), but this process will continue if the excess be washed out.

(5) The different varieties of bromide of silver formulated by Stas (all precipitated from aqueous solutions), *i. e.*, the flocculent, powdery, and granular (p. 51), are regarded by the author as varieties of the same substance, namely, *blue-sensitive bromide of silver*, *i. e.*, different aggregations of the same body.[1]

Eder's Cyanide of Mercury Intensifier.—The formula given on page 251 has the disadvantage of not keeping well, but may be restored at any time by the addition of not more than 77 grains of cyanide of potassium. It sometimes happens that negatives long immersed in bichloride of mercury intensify in

[1] Stas did not try precipitation from alcoholic solutions. The reasons why a different variety of bromide of silver forms in alcoholic and aqueous solutions are hinted at by the author in Phot Mitth., xvi. 14: "If we dissolve nitrate of silver in collodion (as Warnerke does), in order to make emulsion, we obtain a solution very prone to deposit the silver again, which is with difficulty soluble in collodion. Even after long standing fine crystals are formed. Thus the silver salt, in its state of forced solution, has a tendency to the formation of a solid body; if, under these circumstances, its particles meet with bromide of ammonium, or similar substances, the bromide of silver formed will separate in a much coarser form than when formed in dilute aqueous (Stas), or gelatinous solutions."

The question as to what variety of bromide of silver would be formed in mixtures of alcohol and water has not yet been answered. Reasoning from other chemical problems, such as the formation of calcareous spar, arragonite, and chalk, we might expect both varieties to be formed.

the thin places very quickly under the cyanide of mercury, but very slowly in the high lights (*i. e.*, sky in landscapes), so that these appear white on the reverse side, while the others are brown. If the intensification is pushed, the thin parts will lose, while the high-lights continue to gain. With negatives of medium density it will be well to stop the action before the sky has become brown on the reverse side.

The author lately treated a large number of negatives with Eder's, Edwards', Chardon's, and the iodide of mercury formulæ. The result was that Eder's proved itself superior to the others in non-actinic density, which it owes to its fine coffee-brown color. But it must be observed that the tendency to frilling which is manifested by many plates, is decidedly increased by the cyanide of mercury.

Setting Power of Gelatine Emulsion.—This is affected in a remarkable manner if the salts are in strong solution. The author prepared an emulsion by the formula on page 202, but containing only half the given amounts of gelatine and water. This emulsion would not set even when cooled with ice, but did so rapidly when diluted down three times.

Cooking Emulsion in a Porcelain Pot, as described on page 203, will bring the temperature inside the same not higher than 195°. In order to attain a higher temperature, and so hasten the cooking, the emulsion may be poured into a glass flask, which is set in water at 212°.

Draining the Emulsion (page 210), which is quite necessary, because the adherent water would dilute

it too much, may be aided by wrapping up the pieces in a muslin cloth and squeezing.

Sulphite of Soda in the Pyro-developer. — A correspondent of the "British Journal" states that this salt, when added to the pyro-developer (page 245), confers such keeping qualities upon the latter that four plates may be developed, one after the other, with the same solution.[1]

Dried Emulsion.—Instead of allowing the finely divided emulsion (page 212) to dry, it may be poured out into a flat, clean, porcelain tray in a thin layer, and allowed to set and dry there. If pressed for time, the operator may break up the mass after setting with a glass rod, and pour on alcohol a few times.

Removing Green Fog.—Abney states that the green fog so often seen in gelatine plates may be removed by dipping the plate into bromide of iron until it is bleached, and then treating it with the ordinary ferrous-oxalate developer until it has regained its black color.

Mix together equal parts of chloride of iron solution, 1 : 24, and bromide of potassium solution of the same strength, and immerse the plate. When the negative is bleached (it is converted into bromide of silver), wash well, and lay it in fresh ferrous-oxalate developer. Chloride of iron solution may be used alone, but works slower.

The Addition of Dextrine or Sugar to the Emulsion has been recommended by many writers as aiding

[1] The translator has repeatedly developed many collodio-bromide plates with the same mixture of pyro and ammonia without any addition of the salt mentioned.

in the penetration of the developer and fixing solutions. But dextrine will sometimes cause fog (Eder). Sugar is preferable, and has long been added to the gelatines used in pigment-printing for the same purpose.

C—NEW POSITIVE PROCESSES.

1. The Platinum Process (Platinotype).

Pizzighelli and Hübl's Platinum-printing Process.—Willis' process has already been spoken of on page 45. An interesting paper has lately been published[1] on the subject of the platinum process by Pizzighelli and Hübl, giving all necessary details for working it, together with a sample print. The materials made use of in the preparation of the paper are (as before) potassic chloro-platinite and ferric oxalate, in the form of a mixture of 1 part of the former to 1–1.2 of the latter.[2] The authors recommend the so-called ivory-paper, calendered or uncalendered, made by G. Koeder, Wallfischgasse 10, Vienna. This requires sizing with gelatine or arrow-root; the paper being floated upon a one per cent. solution of the same for two or three minutes. The tones obtained from the gelatine-sized paper are bluish-black, those from arrow-root brownish-black.

Preliminary Solutions: (*a*) 154 grains of gelatine swollen in 28 ounces of water, and dissolved at 140°

[1] Die Platinotypie von Pizzighelli und Hübl. Wien und Leipzig Verlag der Phot. Corr., 1882. Prize Essay of the Vienna Phot. Society.

[2] These solutions, together with all other articles needful for the process, are now furnished to the trade by Dr. E. A. Just, Vienna; a fact that will aid considerably in its introduction and use.

F., with the addition of 46 grains of alum and 7 ounces of alcohol to prevent frothing.

(*b*) 154 grains of arrow-root rubbed up with cold water, then poured into 28 ounces of boiling water, and 7 ounces of alcohol added.

As the lower side of the paper when hung up has a thicker coating than the upper, it is necessary to refloat the paper and hang it up the reverse way.

The platinum salt necessary for sensitizing (potassic chloro-platinite) may be found as such in the trade. It is dissolved in 6 parts of cold water, and should be entirely soluble. The ferric oxalate, on the other hand, is not always constant in composition, and must be analyzed before use. But the standard iron solution is a trade article. It should give no precipitate with red prussiate of potash, nor become turbid when boiled with ten times its volume of water.

Sensitizing Solutions.

(*a*) Platinum Solution,	. . . .	408 minims.
Iron "	. . . .	374 "
Water,	. . . . .	68 "

If greater brilliancy is desired, chlorate of potash may be added. To $3\frac{1}{2}$ ounces of the standard iron solution, add 6 grains of chlorate of potash (chlorate of iron solution). Then mix 408 minims of platinum solution, 306 of iron solution, 68 of chlorate of iron solution, and 68 of water.

Pizzighelli and Hübl recommend that for copies of pencil-drawings this solution be diluted with an equal volume of water.

The paper is secured with drawing-pins, and the

solution evenly spread upon it with a flannel mop or large brush, taking care to avoid streaks. This operation must take place in a feebly lighted room,[1] the paper being three times as sensitive as silvered paper; it is then *immediately* dried at 86°–100°.

The drying must neither be done too quickly nor too slowly; the brushes used for spreading the solution must be changed every 15 minutes; and the mixed sensitizer must be used up quickly. The dried sheets of paper are to be kept in a chloride of calcium box. *Absolute dryness is a sine qua non.*

Only a feeble image appears on printing; the yellow paper becoming brown, and if the action is continued, light in color again. The exposure to light is about one-third of that required for silver printing.

For developing, Pizzighelli and Hübl recommend an agate-glazed iron pan supported in a hot-water bath at 176°–185°. The developing solution is composed of neutral oxalate of potash dissolved in three times its weight of water, and acidified with oxalic acid (absolutely necessary). The exposed sheets of paper are drawn slowly over the hot solution; the development takes place instantaneously, giving a picture of a deep black color; the print is then immediately laid in a solution of 1 part of hydrochloric acid in 80 parts of water, and this acid wash is to be changed until no further yellow color appears (three changes of ten minutes each will do). The pictures are finally rinsed with water to remove the acid.

[1] Pizzighelli and Hübl recommend subdued daylight, as the fluids are hard to see by gaslight.

The developer may be used for a long time; the platinum may be recovered by boiling with one-quarter part of a saturated solution of sulphate of iron.

The value of the process rests in the facts that the image is *chemically permanent*, and that the printing and finishing are easily and quickly done. It is an important recommendation of the process, too, that ready-sensitized paper of good keeping qualities may be had as a commercial article, a quire costing 24 marks ($6); a somewhat higher price than silvered albumen paper, which is not more than 15 marks.

2. New Silver Printing Processes.

Willis' Permanent Sensitive Paper.—A solution is made of 462 grains of citric acid in 6,930 grains of distilled water. Albumenized paper is silvered as usual on a bath about 1 : 10, and hung up to dry. When surface dry, the edges are blotted off with paper, and the sheet again floated for about ten seconds, *on the reverse side*, on the citric acid solution, and again hung up to dry. (The author finds it more convenient to lay the citric acid solution on with a brush.) If well dried and kept in a perfectly dark place, it will be good at the end of two or three months.

It is often desirable to keep over ordinary silvered paper for several days or longer, particularly when unfavorable weather or other causes have interfered to prevent its being used immediately. It is well known to become more or less spoiled under these

circumstances, but may be saved by dabbing it over on the wrong side with a sponge filled with citric acid solution. The paper then keeps white, prints well, and since the acid does not come directly into contact with the silver, and is washed away before toning, it does not injure the image, and the toning is not so tedious as when the acid is applied to the silvered surface.[1]

The Gelatino-chloride Process of Eder and Pizzighelli is useful for making window transparencies, lantern positives, reproductions of negatives, etc. The principles have already been given on page 74.[2]

1. *Preparation of the Emulsion:* Dissolve 308–385 grains of gelatine in 3080 grains of distilled water, adding 108 grains of chloride of sodium, or 98 grains of chloride of ammonium; set it in water at 104°, and add 231 grains of nitrate of silver dissolved in $3\frac{1}{2}$ ounces of water. (Directions for mixing, see page 199.) The emulsion is allowed to set, divided up, and washed in the same manner as a bromide emulsion. Eder, however, has advised the precipitation of the silver with ammonia (until the oxide is redissolved). Fogging is not to be expected, but if bad gelatine be used there may be frilling of the

[1] A very effective and convenient method of keeping over paper that has been silvered (but not fumed) is to cut it down to the required sizes and lay it between two sheets of white blotting paper which have been soaked in a saturated solution of bicarbonate of soda and dried. A large printing-frame forms a convenient press to keep it in, and, if the silver-bath contains a small amount of alum, the paper will keep in this condition for a long time, the prints from it being indistinguishable from those made on freshly silvered paper.—Tr.

[2] See also, Phot. mit Chlorsilber Gelatine Von Eder und Pizzighelli, Wein und Leipzig, Verlag der Phot. Corr.

film. The plates are prepared like gelatino-bromide plates. They are first coated with chrome gelatine (p. 212), and warmed before pouring on the emulsion, which is conducted as described on page 212, as well as the drying. The films are decidedly thinner than gelatino-bromide films.

Exposure. — When making transparencies from negatives a printing-frame may be used, setting it up at say 5 feet distance from a fish-tail burner (exposure 30 minutes), or 20 inches (4½ minutes). If daylight be used, from 1 to 3 seconds may be given, or if the illumination be very strong, a fraction of a second will be enough.

The Development is best done with acid citrate of ammonia and a mixed solution of iron (1540 grains sulphate of iron, 10½ ounces water, 2 to 4 drops sulphuric acid). Eder and Pizzighelli give the following directions for preparing the acid citrate of ammonia: Dissolve 9240 grains of citric acid in 4⅕ pints of water, anb add ammonia until very faintly alkaline. If an excess of ammonia has inadvertently been added, heat the solution until it is driven off and a neutral reaction obtained. Now add 6160 grains of citric acid and enough water to make the whole measure 8⅖ pints (for this about 14 ounces of water will be required). This solution may be made up in large quantities, and will keep indefinitely, in well-stoppered bottles, if a few drops of carbolic acid be added.

Shortly before use, mix of the

Citrate of Ammonia Solution,	. . .	90 measures.
Sulphate of Iron	" . . .	30 "
Common Salt (1 : 30)	" . . .	6 "

"The latter fills the office of restrainer. The solution is perfectly clear and never deposits. Its color when freshly mixed is light green, and becomes somewhat darker by exposure to the air, but keeps much better than the ferrous-oxalate developer. The mixed solution may be used throughout an entire day for different plates if small additions of fresh fluid be made from time to time to replace waste."

"The exposed plate, which may show but a faint trace of an image, or even none at all, is laid in a tray and quickly covered with the developer. If the exposure has been correct, the development goes on very rapidly, the image appearing within a minute, and gradually gaining strength; the deep shadows first appear, followed successively by the half-tones and details in the high lights. The development is generally complete in from five to ten minutes."

The image is *entirely visible by reflected light*, less so by transmitted. The development is to be continued until the highest lights begin to lose their purity and turn dark; the plate is then well washed and fixed.

For the effect of this developer on the two kinds of emulsion, see page 76. Plates having received a normal exposure and developed with a large amount of chloride of sodium have a darker tone than those where but little chloride was used. Plates to which a longer exposure was purposely given with the intent to use a large amount of chloride have a more yellowish-red tone, particularly if the developer was diluted with an equal volume of water.

The chlorides of ammonium and potassium act in

the same manner as chloride of sodium. Bromide of potassium has much greater restraining powers. Weak developers give images of a reddish tinge. Increase of acid in the developer (citric or acetic acid) retards its action and lessens sensitiveness. The original paper also speaks of the gallic acid, and the costly hydrokinone developers. For fixing, a solution of hyposulphite of soda (1 : 10–1 : 20) is used; the fixing is accomplished in this weak solution better than in a strong one, and the risk of frilling is much decreased. The plates after being fixed are washed off several times in water and then set under the tap for 1–2 hours. The pictures are toned after fixing in a Sulpho-cyanide of Ammonium bath:

(*a*) Water 17½ ounces, Sulpho-cyanide of Ammonium 308 grains, Hyposulphite of Soda 15–77 grains.

(*b*) Water 17½ ounces, Chloride of Gold and Potassium solution (1 : 50) 510–680 minims.

The solutions are to be mixed before use. The bath will keep at least a week and may be used repeatedly by adding fresh gold. The pictures tone evenly, and the process must be stopped as soon as the right color is seen, otherwise the most delicate shades become bluish. This will sometimes happen upon drying the plate, when the color becomes darker.

When used as window ornaments, a sheet of ground-glass is suspended behind the picture. The following mixture may be used to replace the ground-glass. (*a*) Water 100 parts, gelatine 5, chloride of barium 6. (*b*) Water 100 parts, sulphate of soda 15, gelatine 5. Upon mixing these a white emulsion of sulphate of baryta is formed. The chloride of

sodium (bye-product) may be removed by washing. The washed emulsion is warmed and flowed upon glass in the regular way. E. and P. recommend the ammonia emulsion for reproductions of negatives. Paper may easily be coated with the emulsion by floating (page 267), and E. and P. further recommend the addition of 10 per cent. of glycerine to the emulsion in order to make the paper pliable.

3. New Enlarging Processes and Apparatus.

Winter's Enlarging Process with Electric Light.— Winter Brothers, in Vienna, make principally enlargements upon linen (shirting) from negatives and photographs sent to them by other photographers. The tone of the finished picture is generally sepia-brown, the original tone of the enlargement being of much importance here. German shirting is generally used, the English article containing too much of a greasy substance to be useful for the purpose.

The shirting is salted in large vessels measuring about five feet by four, made of papier maché, lined inside with white enamel. They are supported in the middle on a ball-joint so that they may be easily turned in any direction. The solution was formerly composed of bromides only, but at present the formula stands as follows:

Bromide of Potassium,	3 parts	(by weight).
" Cadmium,	1 "	"
Iodide of Potassium,	1 "	"
Water,	240 "	"

Four men are required for the next operation, which consists in inclining the vessel so that the

salting solution collects entirely at one side; two assistants now hold a stout glass rod diagonally over the vessel; the shirting is dipped into the bath and then drawn over the rod so as to be freed from superfluous liquid before being hung up to dry.

The sensitizing or silvering is done in the same manner in a room with yellow-glass windows. The shirting is dipped, drawn over a glass rod, and hung up to dry as before. The silver bath is made thus:

Nitrate of Silver,	4	parts (by weight).
Citric Acid,	1	" "
Water,	140	" "

The enlargements are made by electric light. Siemen's apparatus driven by a six-horse power engine is used. One light of 6000-candle power (see page 109) supplies three enlarging cameras placed side by side with their axes directed towards the electric light, which stands just at the focus of the condensers of each camera. The condensers concentrate the light upon the negative to be enlarged, and the image is thrown directly upon the shirting, which is stretched out upon a screen moving on a sort of tramway. The distance of the screen from the lens was about 15 feet in the case of the manipulations witnessed by the author.

The exposure varies from 10–30 minutes; much depending upon the skill of the operator in determining the right time. A faint image could be seen after exposure.

The shirting, which has not gained in stiffness by the salting and sensitizing, is then brought back to

the washhouse and developed in one of the trays. The developer is composed of

Pyrogallic Acid, ...	10 parts.
Citric Acid, ...	45 "
Water, ...	410 "

Thus the developer contains a large proportion of acid. When used it is warmed to about 100° F., but still works rather slowly, eight minutes being generally required to complete the development. An assistant gathers up the picture in a lump and washes it just like any article of clothing. Plenty of water is used, and the picture passed from one vessel to another until all soluble matters are removed.

The picture is now toned with gold in the ordinary way, then fixed and subjected to a washing much more thorough than the previous one, the toughness of the material permitting a much quicker and more effective washing than a paper print.

After drying the print appears rather rough, all the threads of the stuff standing up. Waxing is resorted to to remove this, and it is applied with heat in a semi-liquid condition. This gives the picture smoothness, brilliancy, and transparency of shadow without injuring the whites.

The price of the picture depends upon the labor afterwards put upon it by the artist; a three-quarter length costing on the average $25.

Besides portraits, Winter Brothers also make reproductions of classical pictures and drawings upon various fabrics, generally without retouching. These find a ready sale.

Brandt's Enlarging Apparatus with the Lantern.— This consists of a table-like stand about a yard in length. It has two extensions each a yard long, so that the total length can be made about 9 feet if desired. On the stand is a plate-holder placed vertically with four inner frames or kits admitting plates of various sizes. The focussing may be well done on a glass plate covered with white paper and set in the position afterwards occupied by the sensitive film. The lantern body has two wooden frames, the larger one of which is pushed in from the side and allows the transparent positive to be moved from side to side. The smaller one holds the positive and has a vertical movement and acting together with the springs in the other gives the positive any required position before the condenser. The new form of petroleum lamp gives a powerful light, particularly if an addition of camphor be made to the oil.

The apparatus is intended for use in the dark-room, and is excellent for the purpose on account of its convenient arrangement.

4. New Permanent Printing Processes.

A large number of interesting publications have lately appeared on the new permanent printing processes in fatty inks and gelatine. The limits of this work do not allow us to enter into detail upon the subject, but we give the following list for those interested:

Lichthochdruck, Verfahren zur Herstellung von Druckplatten für die Buchdruckerpresse mittelst Lichteinwirkung. Von Carl Bolhövener und E.

Heidenhaus in München. (Patented in Germany from Oct. 4th, 1878. See Phot. Mitth., Jahrg. xvi. p. 76.)

Photogravurverfahren von Gobert, nach Bulletin de la Société Francaise de Phot. Phot. Mitth., xix. 8.

Photogravurverfahren nach Garnier, nach Bull. d. l. Société Fr. d. Ph. Phot. Mitth., xviii. 240.

Umwandlung einer Zinkographischen Platte in eine vertiefte geätzte nach Biny. Phot. Mitth., xix. 20.

Hösch über Farbenlichtdruck (Patent from 5th June, 1881), ibid., xix. 40.

Eder's wässeriger Firniss für Lichtdrucke. Phot. Corr. Jahrg. xvii. Phot. Mitth., xvii. 180, 202.

Woodbury's Stannotypie. Phot. Arch., 1882. Phot. Mitth., xix. Augustheft, p. 112.

Ueber Herstellung von Pigmentpapier von A. Ott. Phot. Mitth., Jahrg. xvi. p. 41.

We may remark that efforts to introduce the Pigmentdruck (carbon printing) into Germany have been but partially successful. See Lehrbuch iii. p. 372.

Since the publication of the German edition of this work several matters of "progress" have occurred, which are added below in order to bring the American edition up to the date of its issue.

Dr. Eder, the well-known photo-chemist, made recently some further experiments on gelatine emulsion, which showed that emulsions rich in gelatine ripen quicker than emulsions poor in gelatine, and further that the treatment with carbonate of ammonium increases the sensitiveness and intensity of the emulsion very materially. (See page 224.)

The topic of the day here is Obernetter's emulsion process. Everybody is interested in it, and, after convincing myself in Munich of the importance of the matter, I frankly state that it is the most interesting novelty the gelatine process can show.[1] Obernetter's process seems, indeed, to contradict all experience gathered thus far about the preparation of emulsion. Heretofore we added bromide of potassium to the gelatine, and then silver; Obernetter just reverses this rule. Until now the bromide of silver was formed in liquid gelatine. Obernetter makes it in solid gelatine. Until now we boiled or warmed after emulsifying. Obernetter works cold. Heretofore the dark-room was indispensable for the emulsification. Obernetter works principally in daylight in a closed wash-box. Obernetter is not yet quite prepared to give us all the minute details of the process, but has given the principle of the method, with practical explanations. He took some congealed gelatine containing silver, cut it into strips with a bone knife, and immersed them in a solution of bromide of potassium. The surface became white instantaneously, but the effect soon penetrated into the interior. When such a strip was broken, it became clear how far the formation of the bromide of silver had advanced. One hour, or at the least, two hours afterwards, the formation is finished, and a remarkable diffusion (endosmosis) takes place therein, by which the soluble salts leave the gelatine. To wash it, it is only necessary to conduct water through a pipe into the vessel containing the strips

[1] At the time of the publication of the American edition of this work, Mr. Obernetter's process seems to have lost repute.

of gelatine. Obernetter places for that purpose, the vessel with the bromized gelatine in a tin box, through which water can pass, and as the box is closed, the washing can take place in daylight. By testing the drain-water, one can determine when the washing is complete. The high sensitiveness Obernetter obtains through appropriate additions.

The process is in fact so simple that any photographer can easily use it. Several photographers, as for instance, Angerer, Schaarwächter, Scholten (of St. Louis), etc., had some time ago advised Obernetter to make the process obtainable by all photographers for a remuneration, and now Mr. Obernetter accepts that proposition, and has opened a subscription list. The importance of the matter is understood by all. Mr. Schaarwächter states that he compared Obernetter's plates with the best Berlin plates, and found them of equal sensitiveness. It is to be stated yet that Obernetter's plates contain very little gelatine, in consequence of which the film is thin and very easily washed, so that the manipulation of the plates is much shorter than with common gelatine plates.

Here, the publication of Obernetter's process is anticipated with keen interest. Of course, thus far only subscribers will benefit by it; in any case, it is to be expected that this process will make the gelatine emulsion extremely popular.

In the meantime, science is also incessantly laboring to increase our knowledge of bromide of silver. Tomassi, who has already studied the behavior of chloride of silver in the light, has lately experimented with bromide of silver. He exposed the same for

three months under water, and frequent shaking, to the rays of the sun, and found a loss of from two to three per cent. of bromine. Chloride of silver lost under identical circumstances, from two to twenty-seven per cent. of chlorine. I still believe that the bromide of silver is superficially reduced to argentous bromide (Ag_2Br).

The other day Mr. Warnerke, who divides his time between London and St. Petersburg, paid me a visit, and, among other interesting communications, he told me that he had used with much success the emulsification method recommended by Henderson. There are now so many emulsification methods that it borders on impossibility to give all a fair trial. Henderson's method offers the great advantage that it does away with the boiling. Warnerke says that he obtained with the process a very high degree of sensitiveness. Henderson dissolves 10 grains of gelatine in 1 ounce of water, to which he adds 20 grains of carbonate of ammonium, and 150 grains of bromide of ammonium, 2 grains of iodide of potassium, 3 ounces of alcohol, and 60 minims of ammonia. To this solution add, when cold, 200 grains of nitrate of silver dissolved in 2 ounces of water. After an hour, the whole is ripe for use, and shows then twice as much sensitiveness as wet plates; but after twenty-four hours, the sensitiveness is four times as high. Then add to the mixture from 4 to 5 drachms of gelatine, and when this has become dissolved, 12 ounces of alcohol, in order to precipitate the emulsion, which is then washed ten hours in flowing water. The sensitiveness of this emulsion is ascribed to the agency of alcohol, but I believe

the washing in the cold to be the cause; and this influence seems to be more marked, the more the emulsion is in a liquid condition.

We have now some very interesting communications from Pizzighelli and Hübl, in Vienna. They write as follows: "Of the many recently published formulæ, that by Henderson especially merits mention. It enables the production of plates, which as to their sensitiveness, actually surpass the best plates in the market, and at the same time are perfectly free from fog. The principle of this process consists in making the emulsion in very diluted alcoholic gelatine solution (33 per cent.), and the ripening done through cold digestion with carbonate of ammonium or caustic ammonia. After this the gelatine is added; then follows the washing, and finally diluting to the normal proportion. Immediately after the mixing of the emulsion, the latter allows only red light to pass, and contains extremely fine equal particles of bromide of silver of a diameter of about .0008 mm.; but already after thirty minutes, it becomes by transparency reddish-gray; after three hours, gray violet; and after five hours, deep blue, whereby the size of the grain increases, the diameter of the same amounting finally to .0015 to .002 mm. After five to ten hours, the transformation of the bromide of silver into the granulous modification may be considered as finished, without danger of any longer digestion becoming in any way injurious. The precipitating with alcohol offers the advantage that, through this action, by far the greatest part of the soluble salts is removed from the emulsion. Direct

experiments showed that the emulsions lost through the precipitation five-sixths to seven-eighths of all the salts which were to be removed through washing. Furthermore, the emulsion need not be congealed, and the loss by washing is saved."

The following advantages of this process are especially mentioned by the authors:

1. The emulsification takes place under conditions most favorable to the ripening, as very diluted alcoholic gelatine solution, great excess of bromide salt, presence of ammonia, etc.

2. The gelatine is not subject to the injurious effect of a higher temperature nor that of alkaline substances, as it is only added after digestion, which is also instantly interrupted by the precipitation with alcohol.

3. As stated above, a considerable degree of sensitiveness was obtained, and experiments with Warnerke's sensitometer gave the following data:

An emulsion boiled half an hour gave,	15	degrees.
An emulsion digested cold one hour (with one c.cm. ammonia),	18	"
An emulsion digested cold two hours (with one c.cm. ammonia),	19	"
An emulsion digested cold five hours (with one c.cm. ammonia),	21	"
An emulsion digested cold five hours (with five c.cm. ammonia),	22	"

Therefore, the sensitiveness of the above emulsion stands in the following ratio: 1 : 2, 2 : 3 : 5, 3 : 7, 4; and consequently the emulsion, digested five hours with five c.cm. ammonia, is 7.4 times more sensitive than an emulsion boiled one-half hour.

In any case, the process, after this recommendation, merits special attention.

In Obernetter's process the after-washing serves to remove, after the emulsification, the excessively soluble bromine salt. Monckhoven referred once to a process in which he avoids the washing. He treated the gelatine with carbonate of silver, and then added hydrobromic acid. The full details never became known. Dr. Szekely, in Vienna, recently recommended a similar process. He dissolves 17 grammes of nitrate of silver in crystals in 150 c cm. of water, then precipitates as carbonate of silver with a solution of 10 grammes of bicarbonate of sodium in 150 c cm. of water, the second equivalent of carbonic acid having been removed by boiling. (In place of the bicarbonate of sodium one can also use simple carbonate of sodium which need not be boiled first.) Now wash, filter, and place while yet moist into a tumbler with a pipette, so that the volume of the liquid is equal to 150 c.cm. By gradually adding strong ammonia (about 20 c.cm.) in small portions to the solution of the carbonate of silver, a clear liquid is obtained, which with violent shaking, is poured in small portions in the usual way into the following solution:

Brom. Ammonium, ...	10 grammes.
Gelatine, ...	22 "
Water, ...	150 c.cm.

Finally, the silver bottle is again rinsed with 25 c.cm., and the emulsion is complete. The emulsion in this state, however, is not yet ripe, and must be digested from one to two hours at from 85° to

105° F., in order to obtain the highest degree of sensitiveness. In any case the emulsion is ready for setting in three hours after mixing at the latest; it flows and congeals quite perfectly, makes soft and very plastic negatives with ferrous-oxalate development without addition of bromide of potassium, is free from any trace of fog, and is in character the equal of any of the emulsions known to me thus far. The films dry very nicely upon the plates, and the latter can be used at once after drying. The developer requires no addition of bromide of potassium, as a small excess of brom. ammonium in the emulsion keeps the plates wonderfully clear without deteriorating the sensitiveness in the least.

A few final remarks on this method. The preparing of the carbonate of silver, the washing of the same, and dissolving in ammonia can take place in diffused daylight. The temperature when mixing the emulsion must not exceed from 105° to 120° F. The emulsion is filtered at once after mixing, and poured from time to time, on a test-plate, in order to determine for the future the duration of the digestion according to the temperature used. So long as the emulsion shows transparent, needle-point-like dots, it is not yet ripe, and makes too thin negatives. The time of exposure with ferrous oxalate lasts from three to ten minutes, according to the ripeness of the emulsion and the duration of the exposure. It is well to use up at once the perfectly ripe emulsion —that is, to pour it on plates.

The experiment of pressing the dried emulsion in "noodles," and protecting the same, by washing, from further action of the ammonia, gave gran-

ular films liable to fog. The process has the one drawback—a small excess of bromide of ammonium always remains, which injures the sensitiveness.

One of the most interesting applications of the Obernetter plate is, without doubt, that of the making of reproduced enlarged and reduced negatives. This process works with such certainty that Obernetter uses it in place of the dusting-on method; and he makes from small *cartes-de-visite*, negatives of 7 x 9 inches which as to beauty are the equals of direct negatives. Upon common gelatine plates the process is difficult of execution, as the thick gelatine layer prevents the thorough washing. To insure complete success, an emulsion poor in gelatine, as manufactured by Obernetter, must be used; all other emulsions require too long action of the chemicals, washing, etc., so that they became detached, frill, etc, before the negative can be finished. Obernetter proceeds as follows:

The plate is exposed almost twice as long as usual, then developed with oxalate developer until it has become perfectly black on the back also, for which ten to twelve minutes are required. The plate becomes perfectly black on both sides. Then a two per cent. solution of chromic acid or a solution of

Bichromate of Potash, ...	1 gramme.
Nitric Acid, ...	5 "
Water, ...	100 "

is poured over the unfixed plate until it loses its black color and a light picture appears of pure chromate of silver. Now the plate is exposed to daylight—and in order to remove all chromate of silver,

once washed with quite diluted ammonia, 1 to 100, then with water. Finally, the plate is again placed in an oxalate developer, which is allowed to act until the desired strength is obtained. If the plate should become too strong, the action of the developer is interrupted and the plate washed and fixed.

On the difference of the iron and pyrogallic development much has been already written. Abney recently made some interesting experiments in regard to the action of alum upon gelatine plates to be developed, and found that the pyrogallic developer cannot stand the action of alum, while the oxalate of iron developer can. A plate was half immersed for fifteen minutes in a saturated solution of alum, and then placed unwashed in a pan containing oxalate developer. The half treated with alum developed with more detail and denser. Perhaps this good effect is only owing to the soaking of the film, for an experiment with water showed almost the same result. Quite another result was produced with the pyro developer. The half treated with alum as above, did not show the trace of a picture; the latent image, however, was there; for after the plate had been washed and treated with oxalate of iron, the picture appeared. Chrome alum gave the same result as ammoniacal alum. The experiment shows that alum can be added without danger to the oxalate of iron developer, which might be of benefit with plates inclined to frill.

In the Society for the Improvement of Photography, there has been recently quite a thorough discussion regarding the illumination of the dark-room for dry-plate development. Mr. Prümm remarked that he

always did his developing by the light of his common, yellow, dark-room lantern, which he lets burn as bright, if not brighter, than is customary in the wet process. Certain precautionary rules must of course be observed. When placing the plate in the holder, and when removing the same again, he softens the light or protects the plate in the shade of his body; but when developing such caution need not be observed, as the yellow developing liquid lets little actinic light through, and the plate loses much of its sensitiveness in the moist condition. It is not however advisable to bring the plate nearer than three and a half feet to the light.

To this statement by Mr. Prümm, it was answered from several sides that it is not always possible to keep this distance, especially with large plates, as it is often necessary to approach nearer to the light, in order to perceive the clearness and minute details. Mr. Wight contended that the strength of the light is of less importance than the color. He uses oiled paper for his lantern, and is very contented with it, as he obtains an agreeable and pretty safe light for his plates. It is remarkable indeed that often apparently one and the same color of the light is declared by one party to be injurious, and by another party to be harmless, to the plates. This is explained by the simple fact that the glasses have a very unequal color-transparency, as can be easily observed with the spectroscope. Many red glasses let green light pass through; some yellow glasses let much blue through, others less. Yet more striking is this difference in colored paper. I have examined the red paper which they use in England to wrap

dry plates in, and was often surprised to see how it lets blue light pass. I would in this regard give a warning against the many red aniline colors, which in fact let as much blue as red light through.

At the same meeting, Mr. Wight made an interesting statement on the packing of dry plates. He showed an elegantly bound book, the title of which, "Photographic Plates," is very fitting indeed, for the whole is nothing but a case to transport gelatine plates. Mr. Wight stated that when travelling he had once been forced at the custom-house to open the packets containing his dry plates against all his protests, as the custom-house officers seemed to have a lurking suspicion that the packets contained dutiable articles, instead of dry plates. At another time he was more lucky, as the officers by some other mysterious association of ideas, arrived at the conclusion that the packets contained books, and let them pass without bothering themselves about them; and he added frankly that he had grasped this lucky idea of the custom-house tyrants, and caused these little cases to be made, which enable him to pass his plates through all custom-houses as books. The plates in the case are wrapped in pairs in black paper, the films facing each other, and separated by pieces of pasteboard. It is curious that the plates when packed thus appear almost always moist on the glass side. This phenomenon Mr. Wight believes is not identical with the often-observed fact that moisture will cover a cold glass plate when brought into a warm place; but he assumes that it is caused by the moisture remaining in the films of the plate, no matter how dry they may ap-

pear; and he thinks that the well-known rings which appear in developing, seem the stronger the more moisture covers the plates. These black rings are certainly very annoying to the dry-plate photographer. They usually appear in the course of a few months. In my opinion, they are caused by negligent cleaning of the rough edges of the plate, for if one cuts a prepared gelatine plate in the middle, it will be found that the fresh-cut edge will never give black rings.

My colleague, Mr. Pritchard, sent me two samples of a woven thick stuff, one of a dark carmine red, and the other of a lighter yellowish-red color. The former, called ruby, proved to be much less non-actinic, *i. e.*, much easier penetrable for chemically effective rays than the lighter stuff, called cherry, although the first was preferable for photographic purposes. Pritchard wrote that he had made a photographic test by exposing Warnerke's sensitometer on dry plates five minutes, at a distance of four feet from a gas-jet behind both stuffs. Ruby produced in development No. 10; cherry, No. 2, a striking proof how much easier the darker ruby allows chemically effective light to penetrate. According to Warnerke's index, the latter is in fact nine times stronger than that passed through the cherry stuff. I tested spectroscopically the respective dye-stuffs with which the stuffs had been dyed, by boiling them in alcohol. In solution, the difference in the dye-stuffs became much more prominent than in the concrete condition. Cherry gave a pronounced yellowish-red; ruby however a more carmine-like solution. The latter although

darker, allowed as proved by the spectroscope, the blue light to pass through much easier than the other. I can therefore strongly recommend the cherry, and at the same time I must advise dry-plate manufacturers to employ every precaution in the selection of the red paper which they use for packing the plates. I obtained on several occasions dry plates in red paper, the dye-stuffs of which appeared suspicious to me, and which examined by the spectroscope, allowed blue light to penetrate quite distinctly. Photographers seldom possess a spectroscope; but are more likely to own a sensitometer like Warnerke's, and testing with that, as stated above by Pritchard, can only be desirable in selecting the red paper.

CHAPTER VII.

PHOTOGRAPHIC ÆSTHETICS AND PORTRAIT TECHINQUE.

New Forms.—The varying fashions of the day do not content themselves with the sizes and styles hitherto known. The following styles with names and sizes as given have lately appeared:

	Imperial.	Boudoir.[1]	Promenade.
Card,	10 x 7 inches.	$8\frac{3}{4}$ x $5\frac{3}{8}$ inches	8 x 4 inches.
Picture,	$8\frac{3}{4}$ x $6\frac{3}{4}$ "	$7\frac{3}{4}$ x $4\frac{3}{4}$ "	$3\frac{3}{4}$ x $7\frac{1}{2}$ "

Hartman's Studies on the Anatomy of the Human Head.—A thorough study of the human body is necessary in every branch of plastic art. That portrait painters and sculptors must be familiar with anatomical relations, and that too, in no slight degree if they wish to produce an intelligible work of art, scarcely need be said. But the landscape painter, the architect, and the ornamental draughtsman also, must not slight a knowledge of the human body unless willing to risk the appearance of that which is irrelevant or even bad in his work.

We photographers find ourselves in the same position. True, the camera gives exact pictures. With a limited knowledge of the technical parts of the art of photography we will always be able to obtain

[1] Known also as "Makartformat."

results true to nature in a certain sense. But as soon as we are fairly aware of the fact that we can modify natural effects by arrangement, choice of lighting, and retouching, we also become aware of the necessity of studying the anatomical relations of the objects before us, so that we may not fall into such mistakes as suppressing the essential, emphasizing the trivial, or introducing the totally false and wrong into our work.

The ease with which negatives may be retouched and the increasing recklessness with which it is done will account for innumerable faults. Janssen's work on retouching contains excellent teaching on this point.

I myself some years ago, when writing on the subject of Grasshoff's works, which did so much to develop the then scarcely known art of retouching, had occasion to allude to the danger incurred if retouching is carried too far and without the necessary technical knowledge. The unfortunate predilection of the public for smooth flattered portraits which have been retouched until perfectly devoid of expression, on the one hand, and the disposition of photography to exaggerate details in its monochromatic results not prominent in nature, on the other, justify the art of negative retouching. That which photography renders in a false manner, *i. e.*, the relations of color, and the chemical as contrasted with the optical effects of light, must be rectified by ourselves. But care must be taken not to introduce any object deficient in plastic qualities, as is but too frequently done.

Some time ago I had a conversation with a sculp-

tor about this. He quoted one out of many instances where retouching carelessly done had had a bad effect. He received an order to make a bust of a deceased person from a number of *good* photographic portraits, a task requiring an expert in his department. The portraits were not "good" in an art sense, but in the rather indefinite sense of the word as understood by the public at large. They were well executed, vigorous, highly burnished, retouched, and stamped with the cameo press, excellent if regarded with the public's ideas—but idealized and flattered.

To mould a bust from these was apparently no very difficult thing.

The sculptor however, in looking back to his student days, remembered that anatomy had taught him that the human head contains certain bones. The proofs given to him, alas, contained none. The brow might have been compared to a well-varnished ball, round, without detail to break its unity, and destitute of any depressions. An artistic grain covered all individualizing traits. Was it a "bullet-head?" Had the brow sharp angles? Were the contours of the eyebrows concave or convex? Impossible to tell from the photograph. Were the muscles about the brow vigorous or weak, and were they fat or lean? Nothing in the photograph to guide. Were there crow's feet about the nose, and were the furrows in the apparently elderly head horizontal? Did they follow the outline of the muscles and their movements, or did they run across them in a double line? Not so much as a hint in the photograph, but every thing smooth and neat, beauti-

fully retouched and burnished—modern photography had made a masterpiece—bones, muscles, skin, all were gone, and nothing left but a brilliant surface finished in a workmanlike manner. From this a sculptor might model not one, but twenty-five brows, each more beautiful than the other, anything in short but the original individual. Now for the other parts of the head.

The form of the nose was quite destroyed by an unskilfully placed high-light extending down and terminating at the point like a button. The eyes also, which in nature were somewhat undecided and bleared from age, here had sharply defined pupils with high-lights more boldly than tastefully applied. Being deeply set and not capable of receiving any such high-light, the effect of the photograph was to make them prominent and like those of a lobster.

The furrows around the mouth, the lean chin, even the expressive corners of the mouth were completely destroyed. Nevertheless, the relationship of some of the larger masses, the contour of the head and some other points having been impossible to change, preserved the likeness to some degree, although the smooth, youthful skin on the elderly head produced a painful effect.

If the retoucher of this picture had had some knowledge of the human head, he would have avoided removing such traits as are indispensably necessary to a truthful representation. Can anything justify the retouching of a solidly built and rather flat brow, so as to make it look round like that of a body which has laid in water for 14 days? Should features be thoughtlessly removed, which

have gradually formed themselves as the result of the character, as well as the action of the underlying muscles during many years, and this merely to give the photograph a well-finished appearance?

The picture may be irreproachable, and yet all of these details which make nature life-like may be preserved, if due care be taken not to destroy that which is anatomically necessary.

I will now make a very brief attempt to name those organs which are the most important ones in deciding human lineaments. Those desiring to pursue this subject will find valuable information in Harless' *Plastischer Anatomie* (Stuttgart, Ebner, and Seubert). Janssen's work on retouching also treats of this subject briefly and clearly.[1]

A few remarks must first be made on the skull as the chief element of the human head. It is well known that it contains a number of hollows serving as receptacles for the most important organs of sense, but we are more especially interested in its exterior formation and appearance. In the second place, the skull is the support of numerous muscles, ligaments, tissues, bloodvessels, and nerves which must be known in order to understand the finer gradations of form, color, and feature producing their effect through the skin. Let us first examine those parts where the bony structure is least covered by muscle:

(1) the upper part of the brow (and cranium),

(2) the upper part of the nose,

(3) the lower borders of the jaw-bones,

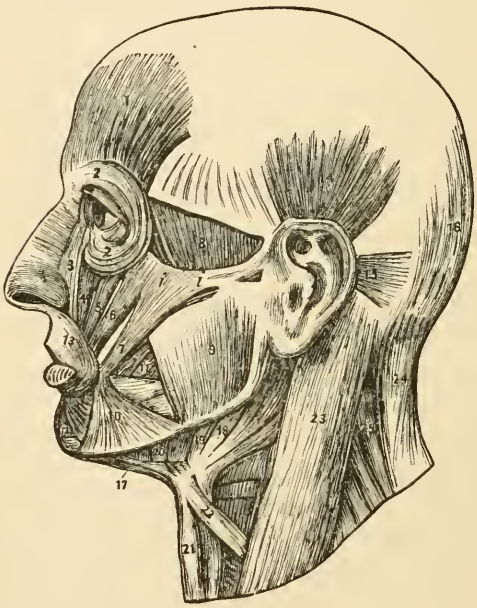
[1] System. Anleitung zur Portrait Retouche, von Janssen, Wien, bei Lehmann und Wentzel. Also Grasshoff, Die Retouche der Photographie, III. Aufl., Berlin, Oppenheim.

(4) the lower and lateral borders of the orbits,

(5) the prominences of the cheeks.

I have arranged Fig. 70 to show the most important muscles.

Fig. 70.



No. 1. The occipito-frontalis, which presents itself as a symmetrical double muscle flat and intimately adherent to the scalp, which carries a similar muscular formation behind on the occiput. The scalp is thin, tough, and permits the characteristic form of the skull to be easily recognized in so far as the hair does not interfere. This formation of the skull is of particular importance at the brow. It is well known

that in different individuals the brow or frontal portions are widely different. In many, the rounding off at the temples is very gentle, while in others it is almost angular. Manifestly then, under a side-light the effect of shadow will be totally different according to the degree of roundness or angularity of these parts. Now, since these forms follow to some degree the nervous convolutions of brain lying beneath, it is plain that they cannot be much modified by the retouching pencil without destroying the character of the brow.

At right angles to the direction of the occipito-frontalis, is a pair of small muscles wrongly called the corrugatores supercilii. The effect of their contraction is to bring the eyebrows nearer together and to throw the skin over them into the well-known furrows rising perpendicularly from the roots of the nose.

The relation of the occipito-frontalis to the overlying skin is this: when contracted, it draws the scalp forwards and the eyebrows somewhat up; the skin consequently is thrown into horizontal folds or creases, which in elderly persons become plastic and constant owing to deficiency of elasticity in the skin.

Let us imagine the occipito-frontalis muscle in a state of contraction. Then the overlying skin will be drawn into a smaller space and consequently thrown into folds. The greater the elasticity of the skin the less marked this will be, and vice versa.

No objections can be raised to modifications here if a more youthful expression be desirable.

No. 2. The next muscle to be noticed is the

orbicularis palpebrarum, quite different from the ordinary form of muscle, but just as important to expression from its peculiar construction. If contracted, the eyes must necessarily close. A similar muscle encircles the mouth (orbicularis oris, 13, Fig. 54. Animals are provided with a similar mechanism at other openings of the head; *e. g.* the hippopotamus at the nostrils and even at the ears.) The orbicularis palpebrarum muscle may be divided into an exterior and interior layer; it takes its origin near the inner angle of the eye and is attached to the internal angular process of the frontal bone and a short tendon (tendo palpebrarum), placed at the inner angle of the orbit.

No. 3. The levator labii superioris alæque nasi takes its origin in the depression under the orbit upon the anterior surface of the upper jaw-bone. Its action is to draw the corner of the mouth upwards.

No. 4. The levator labii superioris, a distinct muscle, and separated from the foregoing.

No. 5. The levator anguli oris.

No. 6. The zygomaticus minor (lifting the upper lip).

No. 7. The zygomaticus major.

No. 10. The depressor anguli oris, a somewhat triangular muscle attached to the lower border of the lower jaw-bone, and whose fibres gradually lose themselves in the other structures of the part, antagonizes the foregoing.

No. 12. The depressor labii inferioris has a similar action. Its crossing with the one just mentioned (No. 10), forms the characteristic dimple in the chin.

The muscles of the apparatus of mastication,

particularly the temporal muscles (No. 8), are highly important in their influence upon expression. Proceeding from the temporal bone (on each side of the head) it passes under the zygoma (*ii*) and is inserted upon the coronoid process of the lower jaw-bone. Its action is to draw this bone upwards and at the same time somewhat backwards. The masseter (No. 9), situated immediately before the ear, proceeds in two divisions from the zygoma to the angle and lower border of the lower jaw-bone. These muscles, capable of exerting great power, have but little plastic appearance from the fact of their being covered over by a large gland (parotid) situated in front of the ear.

The neck is furnished with very powerful muscles. I will confine myself to mentioning the sterno-hyoid (21), the omo-hyoid (22), the sterno-cleido-mastoid (23), and the trapezius (24). By their actions the head is inclined from side to side, and they are at rest when the body is in equilibrium *i. e.*, when the weight of the head rests on the first cervical vertebra (atlas). This position is the safest one for portrait taking so far as immobility is concerned. Should this condition of immobility be the result of other causes than the equilibrium of the parts, as for instance, when it is produced by muscular power, it then cannot be called rest, strictly speaking. The proof of this is seen in the difficulty of photographing the unsupported hand.

I would strongly advise those who wish to make thorough studies in this direction to order one of the excellent muscle preparations by Prof. Bock, in Leipzig; it may be had for the moderate price of

9 mk. 20 pf. ($2.30) including packing and description. Well modelled and colored plaster busts may be had of G. Steger, Promenadenstrasse 4, Leipzig. The order should be given for Modellkopf A with muscle, nerve, and bloodvessel preparations. Good, neatly prepared skulls may be had of Apel, Anat-Gebäude, Thierarzneischulgarten, Berlin, for 9 marks.

The Pitch of the Roof of the Glass-house.—At a recent meeting of the Berlin Union for the Advancement of Photography a discussion arose upon the principles of construction of the studio, and the advantages of a low glass-house (10–12 feet measured at the glass wall) were universally admitted for portrait taking, particularly if a northern exposure could be had. Another question that arose was the proper height of the studio at the *back wall.* This of course determines the pitch of the roof. The point to be settled was whether the pitch should be steep or gentle. It was unanimously admitted that the steep pitch cleared itself from snow and rain with greater ease, and was consequently kept clean with less trouble. Another important question was what effect was produced upon the lighting by the steep pitch as compared with the gentler one. Reichard who had lately made alterations in his skylight from the low or flat pitch to the steep model, stated that he found it much easier to command harmonious effects of light since the alterations; this was assented to by a large number of the members present.

In the course of the discussion, however, it appeared that the cause of the better light in Reichard's

new studio was rather to be ascribed to the elevated position of the skylight than the steep pitch of the roof. The old one was in the second story and *opposite to a very high building that threw strong reflections into it*, thus influencing the lighting of the sitter in a very marked manner; the new one, on the contrary, was entirely open towards the north, practically speaking, and removed from the injurious reflections. Therefore the superiority of illumination.

Schaarwächter, who has had much experience in studios with steep-pitched roofs, made the interesting observation that too much diffused light was apt to be admitted in their use, so that under certain circumstances it was difficult to obtain any shaded side to the face.

The steep pitch will undoubtedly cause a greater loss of reflected light when it proceeds from the direction of the back wall, but as the curtains are generally drawn only half way up, this will not amount to much in practice, and the top light may be considered the same, whether the pitch be flat or steep.

It is much the same in the case of the front light; if the back wall be elevated, the side wall facing the sitter is also necessarily elevated. This shuts out a part of the sky that would otherwise send front light to the sitter, and it will be noticeable when the curtains are fully open; but when only half open the difference is much less, so that under these circumstances the effect of *direct* light is but little influenced by the pitch of the roof.

Schaarwächter, therefore, was quite right in saying that much more diffused light was admitted to the

studio through the steep-pitched roof than through the flat model. This may be useful under certain circumstances, but under others mentioned by the same gentleman, not so.

It was also mentioned in the course of the discussion alluded to, that a steep-pitched roof allowed the roof-curtains to be set more horizontally than the roof itself. It is plain that if they are drawn up to a certain point the back wall receives no more light from the roof than it would from a flat-pitched roof. It is further to be observed that with the curtains in this position the upper part of the rear wall is entirely shut out, inasmuch as the reflected light from it does not reach the sitter. Thus, *horizontal curtains, under a steep-pitched roof, decrease the strength of the reflected light and give deeper shadows.*

But it is different when the curtains are fully drawn up—rarely done, perhaps, with single figures, but more often with groups. In such cases, the angle of inclination of the roof-curtains is of no account. The height of the back wall (even with a flat-pitched roof) will have to be governed by circumstances. In Berlin it is usual to have a high back wall (generally the wall of the printing-room), so as to avoid sun-screens as much as possible.

Portrait Taking in Ordinary Rooms, after H. P. Robinson.—Before the introduction of the marvellously sensitive gelatine plate it might be said that "portrait taking without a skylight" virtually meant working in the open air, with all its accompanying evils. Now, however, by the aid of highly sensitive plates, which render a powerful illumination superfluous, portraits may be made, not only in the open

air, but even in ordinary rooms, with the best success. I have even seen portraits made in rooms that were better than those made under the skylight, the reason doubtless being that the former were free from the stereotyped, model-like appearance of the latter. Then, too, the work is undertaken now-a-days with more artistic knowledge than formerly; the lighting of the sitter is better understood, and satisfaction not given by monotonous lighting of the features, relieved by an equally monotonous background.

The simplest form of picture that may be made in a room is the bust, showing only the head and shoulders. Frequently the operator will be cramped for want of space, finding it impossible to get far enough back for full-lengths and three-quarters, the bust then offering itself as the only possible form.

The best room for this purpose is a corner room, with a broad window on one side and a narrower one in the right-hand corner. There the lighting arranges itself. The sitter should be placed near the principal window, and only sufficient light admitted from the other to relieve the shadows. Any modification of light and shade may thus be obtained. If there is no smaller window, a reflector may be used to illuminate the shaded side. A light stand supporting a sheet of paper, or a screen covered with white cloth or paper, serves a good purpose. Another plan is to place the sitter at 10 to 12 feet distance from the window, the camera being near the window, either at the right or left, taking care to choose its position so that there may be a shaded as well as a lighted side of the sitter, the front light alone giving a flat, monotonous result.

Certain bold effects of light are more easily made in a room than in a studio; in fact, they frequently form themselves. Such are silhouettes and Rembrandt effects, which may sometimes be made with but little trouble; care must be taken however, to shield the lens from light which might fall directly upon it and fog the plate, particularly a gelatine one.

Groups may also be made in rooms where there is sufficient space. A group taken in a parlor in accustomed attitudes is far more natural than the hackneyed picture of the studio. Gelatine plates, when used with aplanatic lenses (the Euryscope, etc), will render success possible, the depth of focus of this form of lens being a great point in its favor. The natural background will often be the best, but spotty high-lights must be guarded against. The bright white frame of a picture appearing behind the head of the sitter may produce a very bad effect, as may also white marble mantels, shining porcelain, etc. Such objects must either be removed or thrown into shadow. Many varieties of carpet (not those with brilliant colors) make a good background.

A pleasing effect may be made by arranging the dark side of the background behind the lighter side of the sitter, and *vice versa*. Some corner of the room will often afford such an effect, or it may be artificially produced by setting a screen with two folds behind the sitter. If the latter be lighted from the side, the screen will be light behind the shaded side of the face, and dark on the other side.

CHAPTER VIII.

PHOTOGRAPHY FOR AMATEURS.—ORDER OF MANIPULATIONS.[1]

By the introduction of dry plates as a commercial article, amateur photography has become much more widely extended, especially among scientific men, artists, and professional travellers. We give the following hints for the benefit of such classes, with particular reference to landscape and architectural photography:

Size of the Picture.—The larger the picture, the greater the cost of making it. Large pictures require apparatus of large size, large and costly lenses, plates, developing-dishes, etc. etc., and these are fruitful sources of annoyance and difficulty in travelling. Therefore we recommend the smaller sizes to the amateur. The most convenient is five inches by seven, the so-called English cabinet size. A camera made for this size of plate is compendious, light, and may be easily transported with a few plates anywhere. Many travellers, among them the late Hildebrand, Dr. Ribbeck, also Hofrath Häckel, and Dr. Buchner, have used this style of camera and been well contented with it.

As to the lenses for this size, we recommend an aplanatic of about 18 cm. (7 inches) focus, and either

[1] See, also, "Handbuch der Phot. für Amateure u. Touristen," von Pizzighelli. Vienna.

a Steinheil Aplanatic, No. 3 (price 75 marks), or a Voigtländer Euryscope, No. 1 (price 100 marks), or a Busch Aplanatic of $1\frac{1}{4}$ inch opening (price 58 marks), or a Suter Aplanatic of $1\frac{1}{3}$ inch opening (price 60 marks). The Voigtländer lens will also work on plates 5 by 8 inches. This size has lately been much used by amateurs. Frequently however, more than one lens will be required, from the fact that different subjects and different points of view require a corresponding difference in the amount of angle to be included in the picture. For those cases where a very wide angle (90°) is necessary, we advise the use of a Busch Pantascope of $4\frac{1}{2}$ inches focus (price 84 marks), or the Steinheil Wide-Angle Lens, No. 2 (price 60 marks).

These lenses do not allow as much light to pass as those before mentioned, are therefore more difficult to focus, and require longer exposures; they give pictures of nine inches in length and under. The first-mentioned lenses give the sizes of picture referred to *when used for landscapes with a small stop.* They may also be used for portraits. Here they are used with the *full opening* if the light in the glass-house be weak, or if the sitter be placed in an ordinary room. In such cases the exposure will perhaps be as long with the full opening as for landscapes when the smallest stops are used.

The Apparatus for the Negative Process comprises a landscape camera, either with double holders or changing-box and tripod. The accessory articles are, a black cloth for focussing (a couple of yards of a common quality of velveteen will do), a focussing glass, a red lantern, two papier-maché developing-

dishes, two glass funnels, two graduated measures, one holding two fluidrachms and one three ounces, a pair of hand scales and weights, a negative drying rack and grooved box, and a supply of dry plates.

Apparatus for the Printing Process.—For this are required a printing-frame, three dishes, paper, and the materials for toning (chloride of gold) and fixing (hyposulphite of soda). (See Vogel's "Handbuch," iii. p. 345.) We recommend to amateurs the ready-sensitized silvered paper supplied by the United Dresden Factories, or if expense be not objected to, the platinum process.

The carrying cases for the field apparatus are best made of leather. Guerry's instantaneous shutter will answer its purpose very well.

Precautions.—Beginners in photography must not forget that the sensitive plates are *never* to be exposed to daylight nor to the white light from gas or oil-lamps. The light of the image in the camera when everything is fully prepared for exposure is the first that is to reach them. The unpacking of the plates, and placing of them in the holders or changing-box, must be done *by red light only*, and even this must not be allowed access to the film for too long a time.

Routine of Manipulations.—First of all, select the subject to be taken, and if portraits are to be made, remove everything that would not properly belong in the picture. In the case of landscapes, take great care to choose the best point of view, and the most suitable effect of light,[1] then focus as sharply as

[1] One of the principal rules is that the sun must not shine directly on the lens. Excellent hints upon the selection of the

possible without a stop, afterwards inserting the smallest or next to the smallest stop, if extreme definition into the corners of the plate be required. The following operations are now to be gone through with:

1. Loading the holders with sensitive plates (or filling the changing-box).
2. Carrying the holder to the camera.
3. A last look at the focus (this must have been previously attended to).
4. Putting the holder in the camera (without shaking the apparatus).
5. Drawing out the shutter of the holder.
6. Exposure (taking off the cap of the lens and replacing it. *In taking it off, the apparatus must not be shaken*).
7. Closing the shutter of the holder and changing the plate. The taking of the picture is now done; the following operations concern the development and finishing of the exposed plate:
8. Carrying the plate to the dark-room.
9. Taking the exposed plate out of the holder and laying it in the developing-dish (by red light).
10. Mixing and pouring on the developer, rocking the dish, and controlling the development.
11. Short washing.
12. Placing in the alum.
13. Short washing.
14. Fixing until all the white bromide of silver disappears.

point of view and lighting are given in the "Handbuch der Landschaftsphotographie," by Ph. Remelé, 2d edition. Berlin: Oppenheim.

15. Long washing (half an hour under the tap).
16. Drying.
17. Warming.
18. Varnishing.

Consult also the directions given in Chap. VI., B.

A certain amount of routine is necessary in order to perform the operations in the best manner.

Time of Exposure.—This will vary very much, according to the hour of the day and season of the year. The following table of actinic intensities will give a general idea. O means noon-day. One hour, an hour *from* noon, *i. e.*, 11 A.M., or 1 P.M. The remaining figures explain themselves.

Theoretical actinism of the blue sky free from clouds, for the latitude of Berlin, at different seasons of the year and hours of the day.

	0 hr.	1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	6 hrs.	7 hrs.	8 hrs.
January 21, November 21,	$\frac{3}{5}$	$\frac{3}{5}$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{14}$	...	...	...	...
February 21, October 21,	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{2}{3}$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{14}$	...	...	...
March 21, September 21,	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{3}{5}$	$\frac{1}{3}$	$\frac{1}{14}$	...	...
April 21, August 21,	1	1	1	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{2}{3}$	$\frac{2}{5}$	$\frac{1}{14}$	...
May 21, July 21,	1	1	1	1	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{2}{7}$	$\frac{1}{14}$
June 21,	1	1	1	1	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{3}{5}$	$\frac{1}{3}$	$\frac{1}{6}$
December 21,	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{2}{5}$	$\frac{1}{4}$	...	...	...	...	...

The weaker the light, the longer in proportion must be the exposure. For example: If ten seconds be required at noon on May 21st or July 21st, twenty seconds must be given at 6 P.M. of the same day

(other conditions remaining the same), since the strength of the light, as shown by the table, is only half as great; likewise, on January 21st and November 21st, seventeen seconds. At such seasons even a little more time may be given, especially as slight over-exposure is more easily corrected in developing than under-exposure.

Therefore, on the 21st of December, at noon, in clear weather, the exposure should be about three times as long as on the 21st of June at the same hour. Under parallel conditions of weather the exposures will be much alike between 10 A.M. and 2 P.M.

From various unexplained circumstances, the actinism is $1\frac{1}{2}$ times greater in autumn than in spring at the same time of day.

When clouds are present they cause the greatest irregularities; white ones sometimes increasing the power fourfold, while gray ones diminish it. Certain local circumstances also have a great effect; for instance, we exposed eight seconds on an open landscape in July; but under some trees that kept off the light from the sky, we gave a minute at the same season, and three minutes to an interior.

Stops.—The size of the stop is of the greatest importance. The smaller it is, the sharper the definition out into the corners of the plate, but also the less the illumination, and consequently the longer the exposure. Do not therefore stop down the lens too much when making interiors, for the light is weak enough itself. If the ordinary Steinheil Aplanatic be used, with an exposure of 1 second for the largest stop, the second sized stop will require $1\frac{1}{3}$ seconds;

the third, $2\frac{1}{2}$ seconds; the fourth, $3\frac{1}{2}$ seconds; the fifth, 9 seconds; and the sixth, 18 seconds.

For Voigtländer's Euryscope the ratio is similar. The No. 1 stop requiring 1 second; the No. 2, $1\frac{1}{2}$ seconds; the No. 3, $2\frac{3}{4}$ seconds; the No. 4, 6 seconds; the No. 5, 12 seconds; the No. 6, 26 seconds.

With full opening, the new Euryscope will work at least one and a half times quicker than the Aplanatic.

Wide-angle lenses are slower, but when used with large openings the difference is not so striking, Steinheil's Wide-Angle Aplanatic, with the third stop (second smallest), giving a negative in eleven seconds, and the Ordinary Aplanatic with the smallest stop in nine seconds.

The proper time of exposure will often be found only after one or more trials, just as the artilleryman measures the distance of his object by trial-shots. Properly timed plates will show after half a minute's action of the ordinary developer (one part iron, three parts oxalate), only the high-lights of the picture, the shadows coming very gradually. If the image "jumps out," the plate is over-exposed, often disappearing under a gray fog, and is lost; if nothing appear after a minute and a half, the plate has been under-timed. The method of treating such cases by means of a modified developer is given on another page.

The best means of quickly obtaining a general idea of exposure, is to make out a table containing full data of all pictures attempted, and then institute comparisons. We give an example of this from practice on the next page.

Table of Exposures.

Subject.	Season of Year.	Time of Day.	Weather.	Lens.	Stop.	Time Exp'd.	Character.
The Art School; open, well-illuminated street; walls yellowish.	End of July.	Noon.	Sunny.	Steinheil wide angle.	No. 4 (smallest)[1]	16 sec.	Right.
Collection of Plaster casts, in the interior. Plenty of light from the window.	"	2 P. M.	"	Steinheil aplanatic.	No. 4.	60 "	"
Inside the Vestibule, at the Polytechnicum.	"	5 P. M.	Drizzling.	"	"	125 "	"
In the Yard, at the same.	"	4½ P. M.	"	Steinheil wide angle	No. 3.	40 "	"
Exterior of Laboratory.	"	4¼ P. M.	"	"	"	30 "	"
Front of Polytechnicum.	"	5½ P. M	Overcast.	"	"	40 "	Rather overdone.
The same.	"	"	"	"	"	30 "	Right.
The same, Eastern Facade.	"	6 P. M.	Clear.	"	"	40 "	Overdone.
Bow Window of the Art School; open street.	"	3 P. M.	Bright sun.	Steinheil aplanatic.	No. 6.	10 "	Slightly undertimed.
Group under a Balcony.	"	5¾ P. M.	Clear.	Euryscope.	No. 1.	3 "	Right.
Landscape with trees (open)	"	6¾ P. M.	Clear and sunny.	"	No. 4.	12 "	Overdone.
Open landscape, with the laboratory and new buildings.	"	6½ P. M.	"	Steinheil wide angle.	No. 3.	40 "	Right.

[1] The same subject with 10 seconds exposure and more iron in the developer also came up well; we also got a good negative with one exposed 20 seconds, and with less iron and more bromide in the developer.

Portrait taking is far less satisfactory than landscape for amateurs, on account of the restlessness of the subject as well as his high claims and expectations, and the difficulties of posing and lighting. In an *atelier* where special provisions are made for obtaining effects, it is easier. However, as there is generally a strong desire on the part of amateurs to make portraits in spite of drawbacks and failures, we will here give Remelé's rules for taking portraits in the open air. These will be especially interesting to travellers who may wish to make characteristic studies of natives, etc.

"When portraits or groups are attempted in the open air, it is necessary to hang something over the lens in order to prevent false reflections of light; a simple method of accomplishing this is to have two small uprights on the camera, and throw over them a black cloth."

"Use a focussing glass, so as to be sure to have the picture sharp."

"A serviceable background may be made with a piece of gray cloth, supported and stretched upon a light wooden frame by means of rings and hooks. It can be taken down and rolled up after using. Paper backgrounds glued upon linen are not to be recommended, particularly if they are of large size, so that a safe place to keep them in is difficult to find. Besides their being easily injured, such backgrounds seldom remain smooth, and will pucker with changes of weather. This should never be allowed if neat pictures are desired, yet it frequently happens with amateurs."

"Just as important also as a good background, is

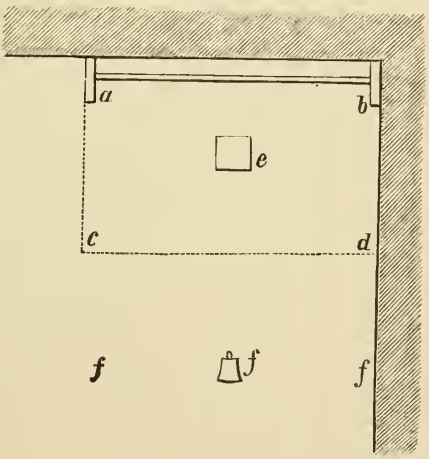
the head-rest, which must be solid and strong. It should be made of iron, adaptable both to standing and sitting figures, with a firm centre-piece, and supports for the head and back. Head-rests with sideway movement and hinges are indeed indispensable for large studios, but unless well taken care of and gently handled—as can scarcely be done while travelling—they soon get shaky."

One of the principle things to be attended to in making portraits in the open air is to choose a suitable place to serve the purpose of the glass house. The beginner will find some difficulty in choosing the best spot from among those which are placed at his disposal. This of all things must be borne in mind: *always make open-air groups and portraits on overcast days if possible.* Then it is that the best results are most easily obtained. In clear sunny weather the crude sunlight will often create such difficulties both by false reflections and its brightness, fatiguing to the eyes of the sitter, that a good picture becomes an impossibility. In respect to the management of light on the sitter, care must be taken not to allow too much top and front light. An excess of top light gives the face a grave, troubled appearance, while too much from the front makes it flat and expressionless. In the country, the large doorway of a barn, preferably facing the north, may be made to do very well. The lighting of the sitter, who should be placed inside, may be well managed by turning him and the background at a greater or less angle. The farther back from the door the position of the sitter, the less top light is admitted, and by moving the background, this latter may be made

darker or lighter at will, while the doors themselves serve to regulate the side light. In order to obtain nicely modelled plastic portraits, it will in most cases be necessary to take the fore-shortened side of the face as the shaded side; the reverse of this proceeding would seldom lead to a good result. For in this case the sitter would have to face the bright light, which is very undesirable, few people being able to bear a strong light without more or less distortion of feature. If possible, always arrange it so that the eyes of the sitter may be directed towards some *dark object*.

If no suitable doorway can be found, another plan

Fig. 71.



must be tried. Let the background *a b* (Fig. 71) be placed in the corner of a yard, the sitter at the point *e*, and the camera either at *f* in the middle, or more

to the side *f* according to circumstances. We will now have sufficient side light, but there will be also too much from the top. This must be softened by something like a screen over the sitter's head, or a curtain, etc. If the side light be too strong, a white paper reflecting screen may be placed at *b*. On overcast days, a few trials will probably solve the problem of lighting the sitter, but it is not so easy on sunny days, when as already mentioned, the false glare from white houses, the ground, etc., makes itself painfully felt. No rules can be laid down how to act under such circumstances, each locality having peculiarities of its own. It will be found that in sunny weather in such places, there will be only certain hours at which portraits may be attempted, depending upon the position of the sun and the illumination of surrounding objects.

It will be well for the amateur to confine himself to busts and three-quarter lengths, because with the exception of the background, no ornament nor furniture will be required, which are difficult to manage unless the ground is perfectly even and smooth. But those who feel inclined to assume the expense of such articles are advised to have them well and substantially made, nothing looking worse than full-length portraits with crooked bits of carpet, rickety ornamental (?) tables, and sham balustrades, with the inevitable flower-pot filled with broken-backed fuchsias or shabby-genteel cactus plants.

The rule of keeping well away from the sun in the case of single figures applies even with greater force to groups, especially if taken without an artificial background; even if the group be posed in the

shadow of a building or large bush, the results will never be first-rate, for the broken-up light of such a position will not give a fine, brilliant picture. On the other hand, it is just as bad to pose the group in full sunlight, at least if the personal likenesses of those composing it be desired. The full light of the sun gives hard, spotty pictures, and each face will partake of this character more or less. But it is quite another thing where the group is to form a more or less prominent *object in the landscape*. To repeat, then, groups properly so called are to be attempted on overcast days, or in the shade of a doorway or shed. The background also may be of various kinds—natural foliage gives a pleasing effect.

The persons should be disposed in a somewhat semicircular form, so that those at the sides may stand a little nearer to the camera than the middle ones. Failures generally come from one or other of the group not being in a good position, or having moved during exposure. For taking groups in rooms, where more attention must be paid to the lighting, see page 321.

Photography in Hot Climates, at Sea, etc.—Philip Remelé (who spent a year in the South Sea with the frigate Bismark) has given a series of articles in the *Phot. Mitth.*, xviii. pp. 1[2], 43, 60, which will be of interest to those contemplating a sea voyage. Burger, in the *Photo. Correspondenz*, vol. xix., also gives valuable hints. We mention this, although probably but few of those to whom this work is addressed will ever have occasion to put them in practice.

The Dark-room.—Many amateurs will not be able to have a room specially devoted to photography. To these we would say, develop at night, when "all the world is dark," and use a red lantern.

Development is seldom attempted while travelling. The plates are merely exposed, and the development put off until the return. Mr. Seligmann, a skilful amateur in Berlin, developed plates exposed in Italy after returning to Berlin, at from two to four months after exposure; he noticed a loss of vigor in them, particularly in the case of instantaneous views. One of the latter developed on the spot with pyrogallic acid was overtimed, the rest exposed under similar conditions, but developed later, appeared undertimed, and required a strong iron developer.

Transportation of the Plates.—Seligmann uses for this purpose a trunk, in which they are so well protected, that in spite of all rough handling on the journey, it is rare to find a broken glass. It is a four-cornered case of stout leather, higher than it is wide, and opening at the side. It is divided into two compartments by a vertical partition, in both of which a number of cases holding a dozen 5 x 8 inch plates are laid over each other, and secured by metal fastenings. In all, the case holds two hundred plates, which are protected by heavy wadding.

CHAPTER IX.

THE PLAQUE PICTURE.

During the past year Mr. F. B. Clench, of Lockport, N. Y., has presented to the public the fruits of an invention of his which represents an entirely new departure in Photography. Some years ago a picture known as the "Cameo" was quite fashionable, but owing to the imperfect apparatus furnished the trade for its production, it was not popular. Another thing against it was, that the convex surface of the picture, being pushed upward, so to speak, rendered it very liable to abrasion and soiling. Mr. Clench has obviated this by depressing or concaving his pictures, and moreover, by an additional improvement in the dies has secured a convex rim around the outer surface of the circle, giving the picture the effect of a plaque, which is exceedingly pretty and very stylish. The actual depression is about four inches by four inches. This brings it considerably within the limits of the cabinet size card, and enables the artist to "double-print" the border, tinted or fancy, as he likes, all around the picture. At each end is a lithograph design peculiarly drawn, with the words "The Plaque" at the top, and the name and monogram of the photographer at the foot. It is a very pretty picture. Larger sizes are made also, and when with velvet border, maroon

or blue, inserted in a gilt frame, are exceedingly rich and tasteful. One of the best things about them is that they enable the photographer to raise the price for his work and secure him better profits.

Fig. 72.

It seems as though the "plaque" was going to be exceedingly popular. A few simple directions for producing the best results with Mr. Clench's outfit, which he supplies under his patents, may not be out

of place. In printing, care should be taken that the paper stretches lengthwise with the mount. The masks which are used should be gummed to the negative, and the cut-out gummed to a clean five by eight glass, and a line running lengthwise with the glass. The vignette board should be covered with a circular opening to print. The border can be printed in the usual way. A zinc pattern is supplied for trimming the pictures the proper shape. A good deal of care is necessary in finishing these pictures. The lithograph surface should be covered well, as it absorbs more of the burnishing fluid than the albumen surface does. The lithograph should also be dried before going through the burnisher, to prevent the dragging of the color. The embossing should not be undertaken when the cards are dry, else they will crack. They should be kept from springing under the lubricator after the lubricator is applied by means of some cheap wood frames one and one-half inches deep, twenty-seven inches long, and seven inches wide inside measure, with a three-fourth inch cleat on each side at the bottom. The rows of pictures should be placed face down, the ends resting on the cleats, and then a row faced up.

Set the frame on two or three thicknesses of wood, and cover with several frames, which may suit one or both, by bringing the cleat under, and over each one, being careful not to let the wet cloth touch the burnished surface. After an hour the pictures are sufficiently moistened and can be embossed. If a pebble border is desired, let the picture be laid face up on the rubber with a circular cut-out (supplied in the outfit) with the border tight over it, to

press heavily, being careful that the guide in the embossing print is in strict position. Put the picture under the guide, fix up and adjust through an opening, remove the guide, lay the thick rubber carefully on, put in the press and put on the pressure gently. A few seconds in the press are sufficient. Sometimes the embossing frame will break the sides of the card. In such cases a slight rubbing of the die with a piece of sandpaper will obviate the trouble. By recent improvements the pictures may be "plaqued" so as to retain *all the burnish.* Although the picture is a patented one, and only licensees can produce it, the manufacturer is given this notice on account of the extreme novelty of his invention with the hope that it will be the means of enabling photographers to get more for their work than the low prices for photographs which they now receive. Colored nicely, or printed with Mr. Seavey's new borders made for them, they are very taking and sure to become popular.

Mr. Clench's results are certainly very stylish. As a pretty "bit" for my book I insert a reduced drawing from one of Mr. Clench's negatives from cabinet size.

INDEX.

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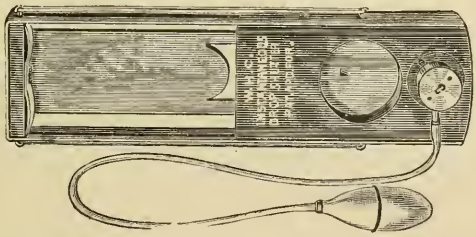

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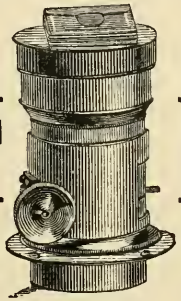

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